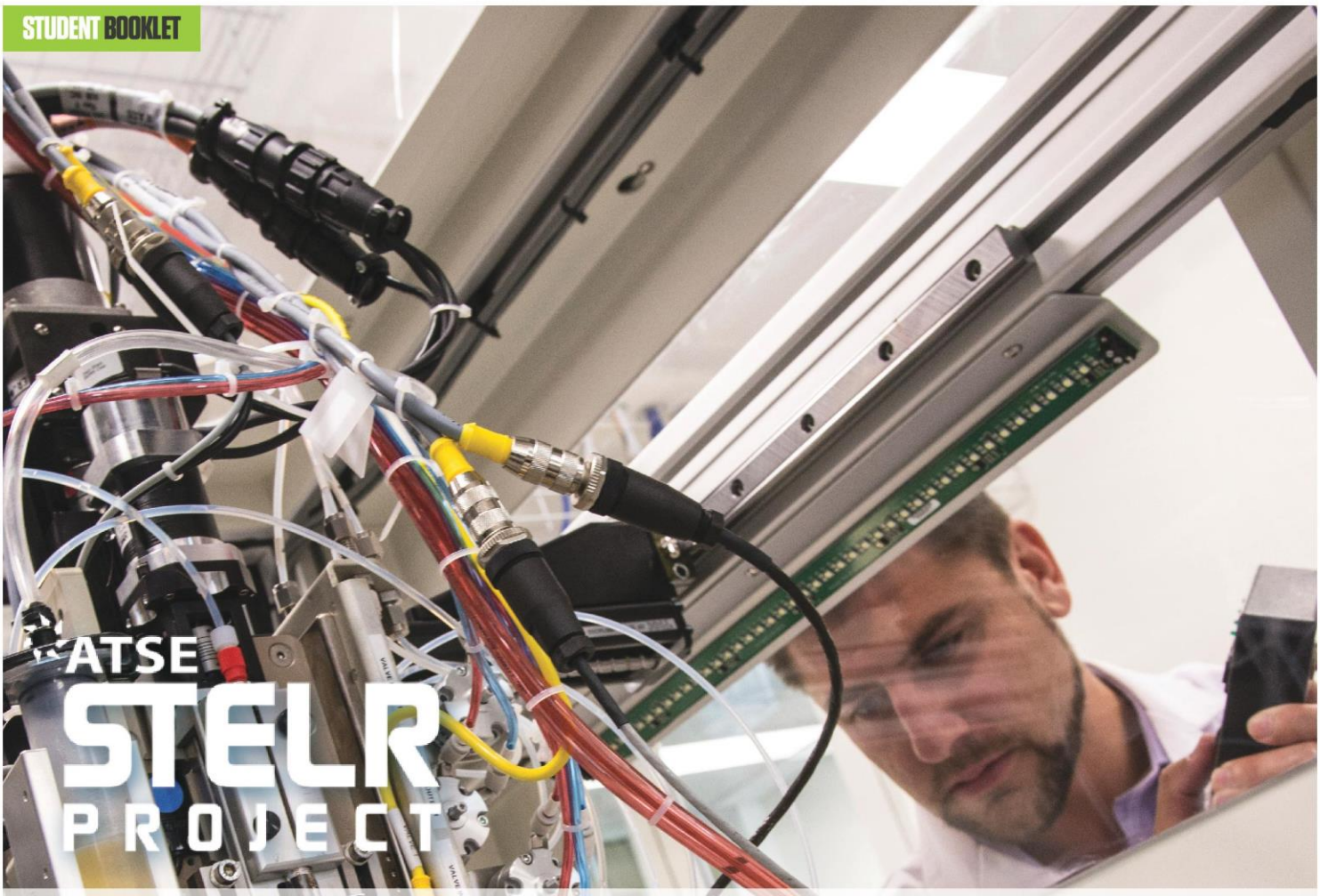
STUDENT BOOKLET



ATSE STELR PROJECT

FUTURE HEALTH

NAME

CLASS

Contents

1. PICTURING THE FUTURE

Have you ever thought about what the future may be like? What will the world be like in 2065? The table below contains some statements about the future.

Question 1

Place a (Y) in the column that best mirrors your feelings about future health.

	Statement	True	Unsure	False
1	Future generations will live to at least 150 years of age.			
2	Diseased organs such as hearts and livers will be replaced with 3D printed working models.			
3	Any cell can be turned into a Stem Cell.			
4	Micro-surgery will be carried out by very small mechanical robots (nanorobots) injected into the body.			
5	A surgery in Adelaide may be performed by doctors in New York, who remotely control instruments.			
6	Every individual will have their DNA mapped.			
7	Artificial Intelligence will diagnose symptoms and select medication.			
8	Clothing will contain electronic sensors to monitor health.			
9	Many diseases included cancer, and Alzheimer's disease will have a cure.			
10	Parents will have their children's stem cells stored for use in possible organ replacement.			
11	The life expectancy of indigenous and Non-Indigenous Australians will be the same.			
12	Robots will be commonplace in hospitals.			
13	3D printed food containing 3D printed health supplements will be available.			
14	Diseases caused by bacteria and viruses will be eliminated.			

2. LIFE AT THE MICROSCOPIC LEVEL

A) THE CELL

In order to understand our health, we need to be confident in our understanding of cell structure.

Activity: Plant and animal cells under the microscope

Examine slides of plant and animal cells under the light microscope. Draw an animal cell and a plant cell in the spaces below.

Question 1

Animal Cell

Question 2

Plant Cell

Question 3

Use research to discover whether you would find each of the following components in either the Nucleus or the Cytoplasm. Place a (Y) in the correct column.

	Cellular Component	Nucleus	Cytoplasm
1	Chromosome		
2	DNA		
3	Ribosome		
4	Mitochondria		
5	Telomere		

B) DISEASE CAUSING AGENTS

Question 4

The presence of one or more of the following can make us feel unwell. Use the internet to research and complete the table below.

	Disease Agents	Example	Disease Caused
1	Bacteria		
2	Viruses		
3	Fungi		
4	Parasites		
5	Protozoans		

C) BACTERIA AND VIRUSES

i) Bacteria

Bacteria are microscopic cellular organisms. A cell membrane and cytoplasm is present, but there is no nucleus.

ii) Viruses

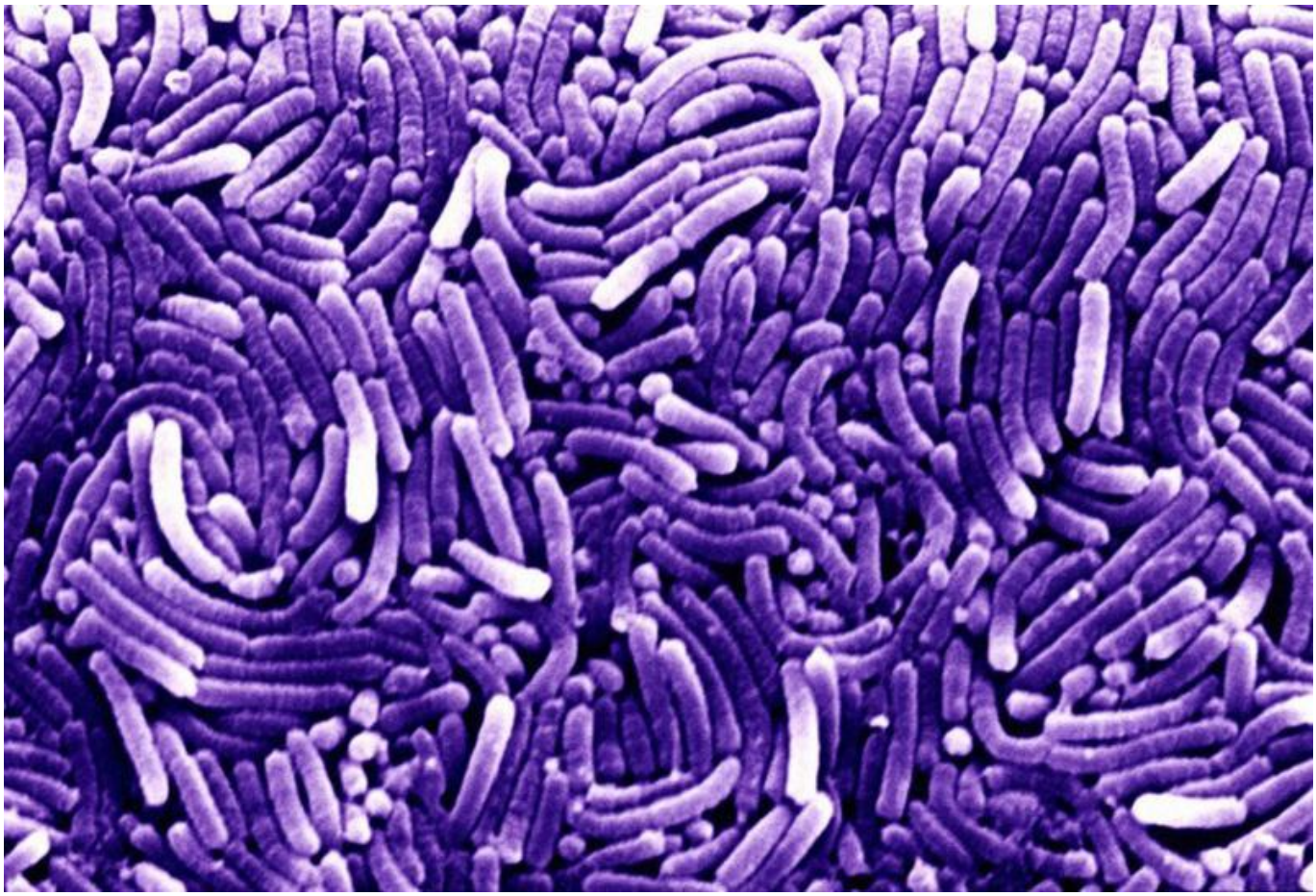
Viruses are acellular and much smaller than Bacteria. They do not have a cell membrane or a nucleus.

iii) Features of Bacteria and Viruses

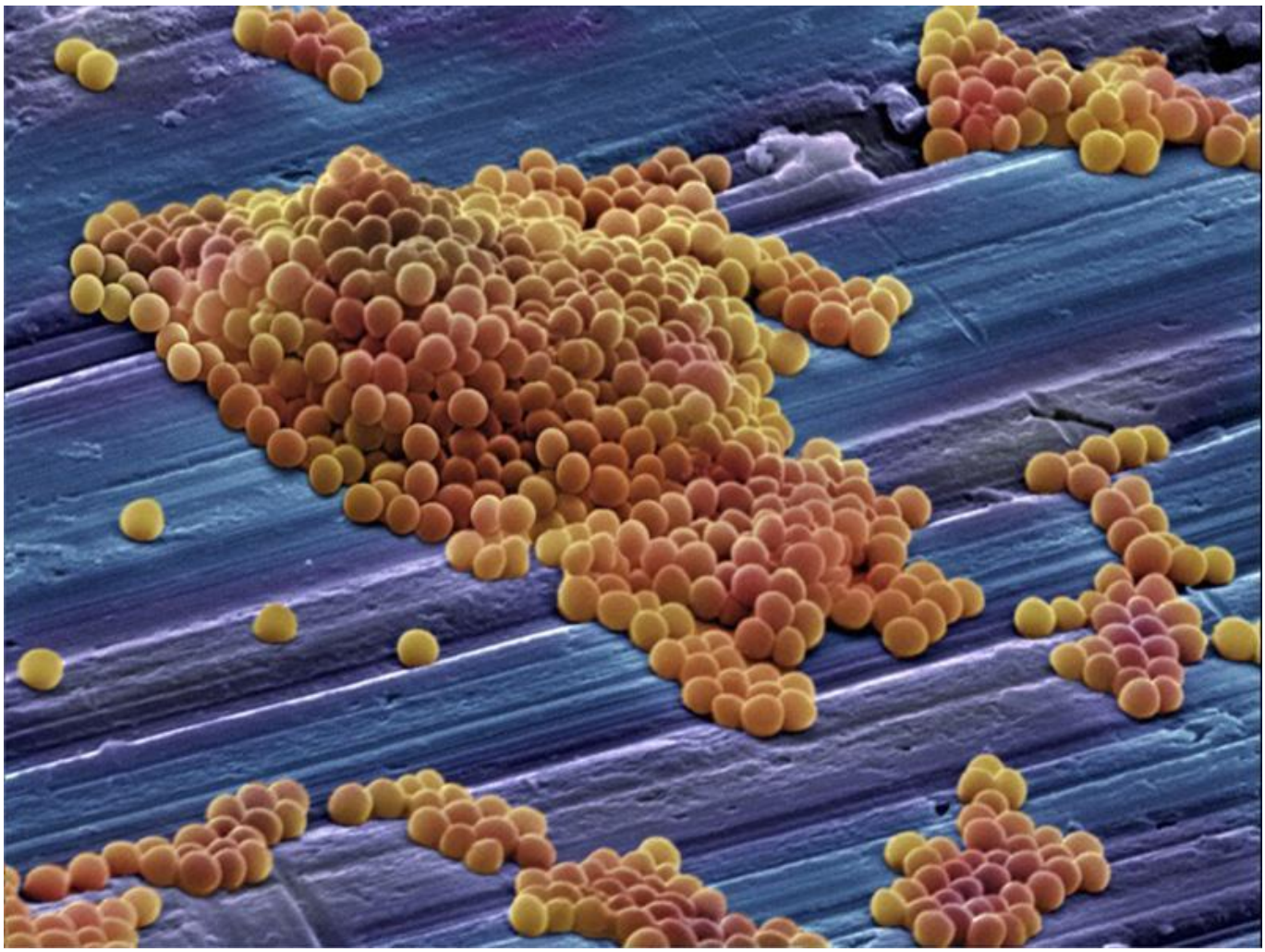
Improvements in Technology have allowed us to see more and more into the structure of bacteria and viruses. The Light Microscope has been surpassed by the Electron Microscope. Viruses can only be seen with an Electron Microscope. This gives us a better understanding of our interaction with bacteria and viruses and so, a more informed approach to coping with disease. Pictures (Electron micrographs) of bacteria and viruses taken through an Electron Microscope are shown in the website below. View the website to answer the two questions below.

Activity: Interpreting Electron micrographs

Visit this webpage: https://bigpictureeducation.com/bacterium-and-virus-images



Heliobacter Bacteria



Clusters of Staphylococcus aureus

Question 5

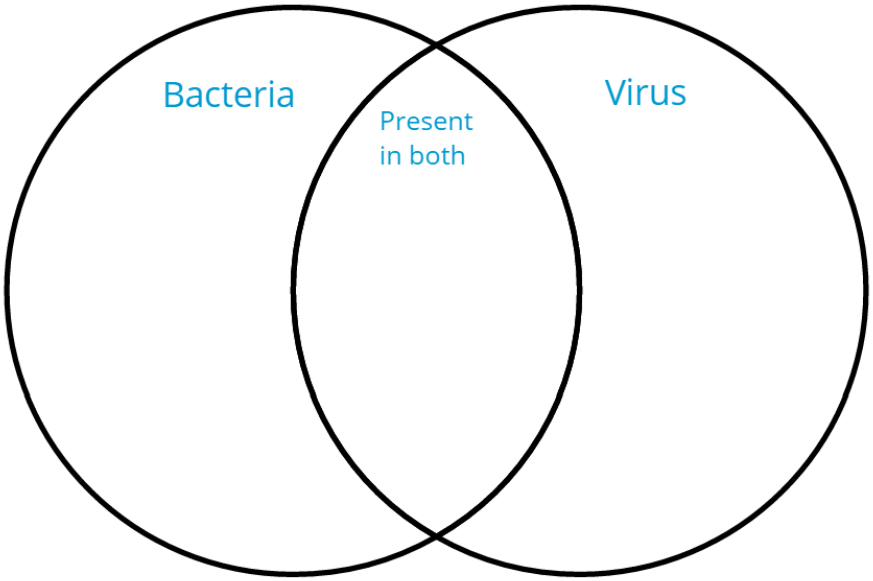
Compare the shape of Staphylococcus and Helicobacter.

Question 6

Compare the size of the HIV virus and a cell.

Question 7

Copy the feature into the Venn diagram



Cellular in nature

Nucleus

DNA or RNA

Chromosomes

Cytoplasm

Activity: Stomach Ulcers - A case study

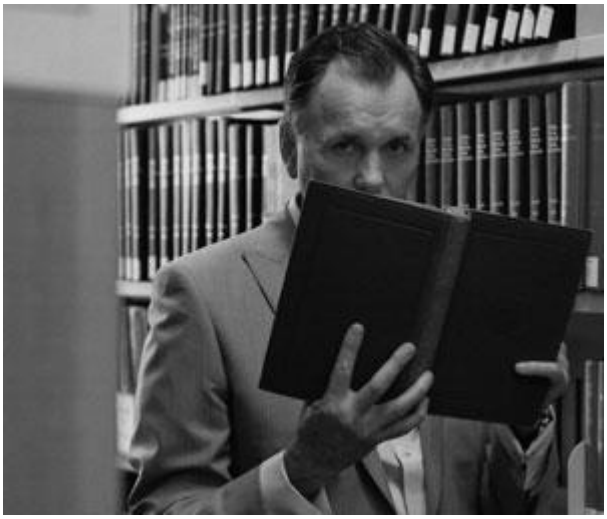
Read this article and answer the questions below.

FROM THE MARCH 2010 ISSUE

The Dr. Who Drank Infectious Broth, Gave Himself an Ulcer, and Solved a Medical Mystery

The medical elite thought they knew what caused ulcers and stomach cancer. But they were wrong—and did not want to hear the answer that was right.

By Pamela Weintraub|Thursday, April 08, 2010



Photography by Ian Regnard

For years, an obscure doctor hailing from Australia's hardscrabble west coast watched in horror as ulcer patients fell so ill that many had their stomach removed or bled until they died. That physician, an internist named Barry Marshall, was tormented because he knew there was a simple treatment for ulcers, which at that time afflicted 10 percent of all adults. In 1981 Marshall began working with Robin Warren, the Royal Perth Hospital pathologist who, two years earlier, discovered the gut could be overrun by hardy, corkscrew-shaped bacteria called Helicobacter pylori. Biopsying ulcer patients and culturing the organisms in the lab, Marshall traced not just ulcers but also stomach cancer to this gut infection. The cure, he realized, was readily available: antibiotics. But mainstream gastroenterologists were dismissive, holding on to the old idea that ulcers were caused by stress.

Unable to make his case in studies with lab mice (because H. pylori affects only primates) and prohibited from experimenting on people, Marshall grew desperate. Finally he ran an experiment on the only human patient he could ethically recruit: himself. He took some H. pylori from the gut of an ailing patient, stirred it into a broth, and drank it. As the days passed, he developed gastritis, the precursor to an ulcer: He started vomiting, his breath began to stink, and he felt sick and exhausted. Back in the lab, he biopsied his own gut, culturing H. pylori and proving unequivocally that bacteria were the underlying cause of ulcers.

Marshall recently sat down with DISCOVER senior editor Pam Weintraub in a Chicago hotel, wearing blue jeans and drinking bottled water without a trace of Helicobacter. The man The Star once called "the guinea-pig doctor" can now talk about his work with the humor and passion of an outsider who has been vindicated. For their work on H. pylori, Marshall and Warren shared a 2005 Nobel Prize. Today the standard of care for an ulcer is treatment with an antibiotic. And stomach cancer—once one of the most common forms of malignancy—is almost gone from the Western world.

Having rid much of the globe of two dread diseases, Marshall is now turning his old enemy into an ally. As a clinical professor of microbiology at the University of Western Australia, he is working on flu vaccines delivered by brews of weakened Helicobacter. And in an age when many doctors dismiss unexplained conditions as "all in the head," Marshall's story serves as both an inspiration and an antidote to hubris in the face of the unknown.

You grew up far from big-city life. What was it like?

I was born in Kalgoorlie, a gold mining town about 400 miles east of Perth. My father was a fitter and turner, fixing steam engines and trains. My mother was a nurse. All the miners owed a lot of money and drank a lot of beer, so Mom said, "We've got to get out of here before we go the way of everybody else." In 1951 we headed for Rum Jungle, where a uranium boom was on, but halfway there we stopped in Kaniva, another boomtown, with a whaling station and high-paying jobs. Then my father started managing chicken factories in Perth. We never wanted for anything. It was like the TV show Happy Days.

What sparked your interest in science?

My mother had nursing books around. I had three brothers, and we always had electronics and gunpowder and explosions and welding. All I can say is that some things you get from your parents through osmosis. In high school I had Bs and Cs, not too many As, but I must have done well on that medical school test and I must have had some charisma in the interview, so I ended up in medicine. Being a general practitioner was all I aspired to. I was good with patients and very interested in why things happened. Eventually I developed a more mature approach: I realized that at least 50 percent of patients were undiagnosable.

You found yourself confronting unexplainable diseases?

In medical school it's quite possible to get taught that you can diagnose everybody and treat everything. But then you get out in the real world and find that for most patients walking through your door, you have no idea what's causing their symptoms. You could slice up that person into a trillion molecules and study every one and they'd all be completely normal. I was never satisfied with saying that by ruling out all these diseases, a person must have a fake disease, so I accepted the fact that lots of times I couldn't reach a fundamental diagnosis, and I kept an open mind.

Is that how you came to rethink the cause of ulcers?

Before the 20th century, the ulcer was not a respectable disease. Doctors would say, "You're under a lot of stress." Nineteenth-century Europe and America had all these crazy health spas and quack

treatments. By the 1880s doctors had developed surgery for ulcers, in which they cut off the bottom of the stomach and reconnected the intestine. We're pretty certain now that by the start of the 20th century, 100 percent of mankind was infected with Helicobacter pylori, but you can go through your whole life and never have any symptoms.

What was the worst-case scenario for ulcer patients?

An ulcer with a hole in it, called a duodenal ulcer, is acutely painful due to stomach acid. When you eat a meal, the food washes the acid away temporarily. When the meal is digested, the acid comes back and covers the raw base of the ulcer, causing pain to start up again. These problems were so common that the Mayo Clinic was built on gastric surgery. After that surgery, half the people would feel better. But about 25 percent of these cured patients became so-called gastric cripples, lacking appetite and never regaining complete health.

With so much physical evidence of a real condition, why were ulcers routinely classified as psychosomatic?

Eventually doctors realized they could see the ulcers with X-ray machines, but, of course, those machines were in big cites like New York and London—so doctors in those cities started identifying ulcers in urban businessmen who probably smoked a lot of cigarettes and had a high-pressure lifestyle. Later, scientists induced ulcers in rats by putting them in straitjackets and dropping them in ice water. Then they found they could protect the rats from these stress-based ulcers by giving them antacids. They made the connection between ulcers, stress, and acid without any proper double-blind studies, but it fit in with what everybody thought.

How did you come to challenge this prevailing theory?

I was in the third year of my internal medicine training, in 1981, and I had to take on a project. Robin Warren, the hospital pathologist, said he had been seeing these bacteria on biopsies of ulcer and stomach cancer patients for two years, and they were all identical.

What was distinctive about these infections?

The microorganisms all had an S-shaped or helical form, and the infections coated the stomach. Warren had found them in about 20 patients who had been sent to him because doctors thought they might have cancer. Instead of cancer, he had found these bacteria. So he gave me the list and said, "Why don't you look at their case records and see if they've got anything wrong with them." It turned out that one of them, a woman in her forties, had been my patient. She had come in feeling nauseated, with chronic stomach pain. We put her through the usual tests, but nothing showed up. So of course she got sent to a psychiatrist, who put her on an antidepressant. When I saw her on the list, I thought, "This is pretty interesting."

Question 8

1. How has the treatment of stomach ulcers changed?

Question 9

2. Why did Barry Marshall drink infectious broth?

Viruses

Activity: Ebola - The work of Anne Carey

Watch this short video and answer the questions below.

https://www.youtube.com/watch?time_continue=1&v=oP-TMvYDHrI

Anne Carey wins West Australian of the Year (Source: YouTube, accessed on February 19, 2017)

Question 10

In which countries did Anne Carey work?

Question 11

Describe the clothing Anne Carey wore while treating victims of Ebola.

Activity: Building a model of a virus

The websites below give you directions on how to build a model of a virus.

http://wonderstruck.co.uk/resources-and-downloads/Student-Resource-Sheet-2.2-Building-Viruses.pdf

https://cdn.rcsb.org/pdb101/learn/resources/zika/zika-paper-model.pdf

Question 12

Build a model of a virus and identify the disease it causes. Take a photo and place it here.

To see how influenza virus infects a human watch the following video:

https://www.youtube.com/watch?v=cE0qdqoBFa8

D. SIZE MATTERS

It is easier for us to understand things that we can see. Understanding things that are really big, like the Universe, or really small like viruses is much more difficult. Experiments and models help us understand how we interact with very large and very small things around us.

To understand how small a virus and a bacterium really are, consider the following:

A 1 metre ruler can be broken up into

100 equal pieces	each piece is called a centimetre (1 cm)
1,000 equal pieces	each piece is called a millimetre (1mm)
1,000,000 equal pieces	each piece is called a micrometre (1um)
1,000,000,000	equal pieces each piece is called a nanometre (1nm)

The length of your toenail is about 1cm.

The thickness of a coin is about 1mm.

The length of a bacterium causing Anthrax is 1um.

The diameter of the influenza virus is about 20nm.

A bacterium cell can be seen with a light microscope with very high power. A virus can only be seen with special electron microscopes.

Question 13

What is the actual size of the virus you used to build your model?

Question 14

Calculate how many times your model is larger than the actual virus?

Question 15

How has your model increased your understanding of the structure of a virus.

In this Unit you learnt about cells, bacteria, viruses and size. Check you have achieved the Outcomes for this unit before you move on.

Under the heading below, list some other things you would like to know more about in this Unit

Question 16

Things I would like to know more about:

3. THE QUANTIFIED SELF

The last few years has seen an explosion in recording devices which monitor an individual's health and activity. These devices include mobile apps, and portable monitoring devices which can also be worn as fashion accessories such as wrist watches, bangles and pendants. These devices can also remind you when you need to increase your activity, track your sleep patterns and calculate the amount of calories you burn during your daily activities. You become both the investigator and the subject of investigation.

How many of you wear such a device?

Poll 1

Take the poll below to see how many of your classmates wear such a device.

- No, I do not wear a device.
- Yes, I do wear a device.
- If Yes, do you share my data with a trainer, "diet buddy" or doctor

Question 1

What types of data can you access about yourself from your device?

A) SAMPLING YOUR DATA: A FIRST-HAND INVESTIGATION

Activity: Measuring your pulse rate

Use the diagram below to record your pulse rate.

- Count your heartbeat for 30 seconds and multiply by 2.
- Rest for 1 minute and repeat the procedure above.
- Do this 10 times.
- Place your results in the table below.

Question 2

Record your results in the table below

Trial	Pulse Rate (beats per minute)
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	

Question 3

What is the range, mean and median of your pulse rate?

Question 4

Choose another person in your class. Record the differences in your average pulse rates.

Question 5

What factors may influence your pulse rate?

Question 6

How could you improve your experiment to obtain a more accurate reading of your average pulse rate?

Question 7

What would be the best way to display your data from the table above?

Activity (optional): Measuring your body temperature

If you have access to a clinical thermometer/ or similar measuring device available from a Pharmacy, you can also measure your body temperature over a period of a week. You may be able to use data logging equipment also.

Present your information in a spreadsheet and upload in the link below.

In the following answers in your spreadsheet:

1. How would you carry out your experiment?
2. Which factors do you need to keep constant?
3. What is the average temperature range for healthy people?
4. Determine the Mean, Range and Median of your data.

Question 8

Attach your spreadsheet of the optional data here

B) INTERPRETING THE DATA FROM SECONDARY SOURCES

Julie wants to improve her fitness. To measure her daily activity she records how many steps she takes on Saturday 20th August 2016.

Her pedometer data is shown below. She aims to complete 15,000 steps.

Time	Number of steps
1am	0
2am	0
3am	0
4am	0
5am	0
6am	0
7am	200
8am	0
9am	400
10am	300
11am	100
Noon	4520
1pm	100
2pm	150
3pm	2400
4pm	3600
5pm	2500
6pm	0
7pm	0
8pm	2500
9pm	1200
10pm	300
11pm	0
Midnight	0

Question 9

What is the Independent Variable in Julie's study?

Question 10

What is the Dependent Variable in Julie's study?

Question 11

What are some factors that may influence the measurement of how many steps were taken?

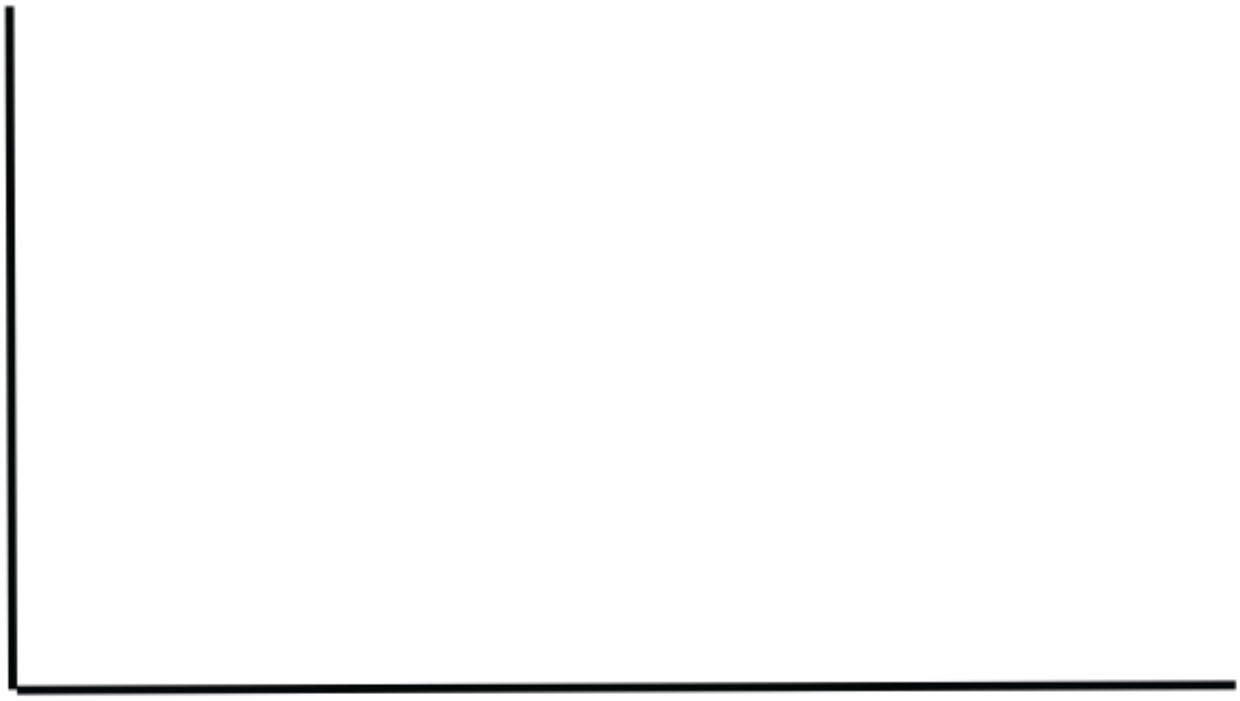
Question 12

Display Julie's results as a line graph below. (Remember to give your graph a title).

If you are unsure on which axis to place the Independent and Dependent Variable, think of a swimmer in a pool. As they are swimming along they are Independent and moving horizontally. The Independent Variable is plotted on the Horizontal Axis.

If the swimmer gets into difficulty, an arm is raised vertically. The swimmer becomes Dependent on help arriving. The Dependent

Variable is plotted on the Vertical Axis



Question 13

What is Julie's total number of steps?

Question 14

How many hours was Julie asleep?

Question 15

During which period of the day was Julie active the most?

Question 16

At which time do you think Julie had her evening meal?

Question 17

At which time did Julie fall asleep?

Question 18

Has Julie met her aim of completing 15,000 steps?

Question 19

Comment on Julie's data in terms of

a) Validity
b) Reliability
c) Accuracy

This is obviously a "snapshot" of Julie's activities over 1 day. Data collection over a longer period will give Julie a better insight into her activity and may lead to changes in behaviour that result in the improved fitness Julie is seeking.

C) THE CONNECTIVITY OF THE QUANTIFIED SELF

How will the collection of data of individuals improve future health?

Sensors collect data. These sensors can be embedded in clothing, the ring on your finger or the mattress you lay on. They can be embedded in your body. In the future this data can be instantaneously transferred to doctors, hospitals, physiotherapists and even your relatives. This data may be even available to your life insurance provider!

Data collected from thousands of individuals can be analysed by Artificial Intelligence systems quickly, and referenced to known treatments and therapies.

Diagnoses will be based on collective experiences rather than an individual doctor's knowledge and understanding.

There are obvious benefits to individual health if your data from sensors, laboratory tests, body imaging (eg X-Rays and CT Scans) and behavioural trends can immediately be analysed, and an appropriate course of action put in place.

Connecting sensors, communication technology and immediate medical analysis will have far reaching benefits including:

a) Improved access to medical facilities in remote areas
b) Earlier diagnosis of health issues in Aboriginal and Torres Strait Islander communities
c) Immediate health care to casualties of disasters
d) Monitoring the progress of rehabilitation and therapy activities
e) Immediate impact of prescribed medication
f) Reducing human error in diagnosis
g) Clearer and more defined images from X-Rays, CT Scans and MRI
h) Recognition of patterns of behaviour in the treatment of mental health issues.

For all these benefits, it is well to remember that a doctor's personal knowledge of a patient's background can aid the doctor in asking more relevant questions than a computer of the patient.

D) CAN THE DATA WE HAVE ABOUT OURSELVES BE USED AGAINST US?

Read this article and construct a table of the pros and cons of sharing data about your health.

https://www.theatlantic.com/technology/archive/2014/11/when-fitbit-is-the-expert-witness/382936/

When Fitbit Is the Expert Witness

An upcoming court case will use fitness-tracking data to try and prove a plaintiff's claim, bringing us one step closer to the new age of quantified self incrimination.

Self-tracking using a wearable device can be fascinating. It can drive you to exercise more, make you reflect on how much (or little) you sleep, and help you detect patterns in your mood over time. But something else is happening when you use a wearable device, something that is less immediately apparent: You are no longer the only source of data about yourself. The data you unconsciously produce by going about your day is being stored up over time by one or several entities. And now it could be used against you in court.

The first known court case using Fitbit activity data is underway. A law firm in Canada is using a client's Fitbit history in a personal injury claim. The plaintiff was injured four years ago when she was a personal trainer, and her lawyers now want to use her Fitbit data to show that her activity levels are still lower than the baseline for someone of her age and profession to show that she deserves compensation.

As an additional twist, it is not the raw Fitbit data that will be used in the courtroom. The lawyers are relying on an analytics company called Vivametrica, which compares individual data to the general population by using "industry and public research." Vivametrica claims that they "define standards for how data is managed, bringing order to the chaos of the wearable." In other words, they specialize in

taking a single person's data, and comparing it to the vast banks of data collected by Fitbits, to see if that person is above or below average.

Vivametrica says that they are doing more than just enabling consumers to get access to their own data. They are also working with wearable tech companies and healthcare providers, and seeking to "reimagine employee health and wellness programs." But what happens when there are conflicting interests between individuals who want to monitor data about their body and employers, wearable manufacturers and healthcare providers, and now the law?

Vivametrica isn't the only company vying for control of the fitness data space. There is considerable power in becoming the default standard-setter for health metrics. Any company that becomes the go-to data analysis group for brands like Fitbit and Jawbone stands to make a lot of money. But setting standards isn't as simple as it may seem.

Medical research on the relationship between exercise, sleep, diet, and health is moving extremely rapidly. The decisions about what is "normal" and "healthy" that these companies come to depends on which research they're using. Who is defining what constitutes the "average" healthy person? This contextual information isn't generally visible. Analytics companies aren't required to reveal which data sets they are using and how they are being analyzed.

The current lawsuit is an example of Fitbit data being used to support a plaintiff in an injury case, but wearables data could just as easily be used by insurers to deny disability claims, or by prosecutors seeking a rich source of self-incriminating evidence. As the CEO of Vivametrica, Dr. Rich Hu, told Forbes, insurers can't force claimants to wear Fitbits. But they can request a court order from anyone who stores wearable data to release it. Will it change people's relationship to their wearable device when they know that it can be an informant? These devices can give their own interpretation of your daily activity, sleep, and moods, and that analysis may be seen to carry more evidentiary weight than the owner's experience.

Insurers can't force claimants to wear Fitbits. But they can request a court order from anyone who stores wearable data to release it.

The law provides very few answers to these questions. In America, the Fifth Amendment protects the right against self-incrimination and the Sixth Amendment provides the right in criminal prosecutions "to be confronted with the witnesses" against you. Canadian courts have similar safeguards. Yet with wearables, who is the witness? The device? Your body? The service provider? Or the analytics algorithm operated by a third party? It's unclear how courts will handle the possibility of quantified self-incrimination.

This becomes significantly more complex considering the variability of data with wearable trackers. The Jawbone UP, Nike Fuelband, Fitbit, and Withings Pulse all have their own peculiarities in how they work: Some will count moving your arms around as walking (which is great if you want writing to

count as exercise), others can't easily register cycling as activity. The sleep-tracking functions deploy relatively crude methods to determine the division between light and deep sleep. This "chaos of the wearable" might be merely amusing or frustrating when you're using the data to reflect on our own lives. But it can be perilous when that data is used to represent objective truth for insurers or courtrooms. And now that data is being further abstracted by analytics companies that create proprietary algorithms to analyze it and map it against their particular standard of the "normal" healthy person.

At one level, this shouldn't really surprise us. The legal system already draws on a range of technological self-tracking devices as forms of evidence. GPS devices and apps for tracking bike rides like Strava have been used in court proceedings around cycling accidents, and of course, there are multiple forms of remote tracking used by the police, like Automatic License Plate Readers (ALPR). The difference is that wearable devices are elective. And when they make that decision they are effectively splitting their daily record into two streams: experience and data. These may converge or diverge for reasons to do with the fallibility of human memory, or the fallibility of data-tracking systems.

This similarity—the fact that both systems can be fallible—is what courtrooms should keep in mind. Courts have experience with this. They know that eye witnesses can't always be trusted, even if they were there to witness the crime. They understand that doctors and other witnesses have expertise, but they aren't all-knowing beings. There are expert witnesses for each side, and judges and juries can consider the general range of human bias and inaccuracy. When large data sets are brought to bear, they should be treated the same way.

Ultimately, the Fitbit case may be just one step in a much bigger shift toward a data-driven regime of "truth." Prioritizing data—irregular, unreliable data—over human reporting, means putting power in the hands of an algorithm. These systems are imperfect—just as human judgments can be—and it will be increasingly important for people to be able to see behind the curtain rather than accept device data as irrefutable courtroom evidence. In the meantime, users should think of wearables as partial witnesses, ones that carry their own affordances and biases.

Question 20

What are the pros and cons of wearing fitness data trackers?

Pros	Cons

E) THE IMPACT OF THE CONNECTIVITY OF DATA ON THE FUTURE HEALTH OF ABORIGINAL AND TORRES STRAIGHT ISLANDERS.

Aboriginal and Torres Islanders have a lower life expectancy than any other first world country Indigenous population. They die nearly 20 years younger than non-indigenous Australians and children are almost five times as likely to die before the age of five than nonindigenous children. Chronic conditions including heart disease, stroke, diabetes and kidney failure are a serious issue in Indigenous communities in Australia. (Resource- Oxfam Australia)

Research one of the successful health programs listed below:

- Mums and Babies Project, Queensland
- Nganampa Health Council, South Australia
- Strong Women, Strong Babies, Strong Culture Program, NT
- The Derby Aboriginal Health Services, Western Australia

Question 21

Which health program did you select?

Question 22

Outline how Artificial Intelligence and Connectivity of Data can lead to improvement in the health and well-being of indigenous communities in the health program you have chosen.

In this unit, you learnt about data sensors, data usage, data display, data connectivity and artificial intelligence, variables, experimental design and units of measurement. Check you have achieved the Outcomes for this Unit before you move on.

Under the heading below, list some other things you would like to know more about in this Unit.

Question 23

I would like to know more about:

---

4. STEM CELLS AND BIO-BANKS

A) WHAT ARE STEM CELLS

Stem cells are unspecialised cells. These cells can develop into the different types of cells that make up the organs and tissues of living things. In humans, stem cells can be found in embryos and different tissues of adults. Stem cells in bone marrow and intestines divide to produce replacement cells for dead or damaged cells every second.

B) STEM CELL TERMS

Research the meaning of the special 'stem cell' terms below.

Question 1

Differentiation

Question 2

In-vitro

Question 3

Pluripotent

Question 4

Proliferation

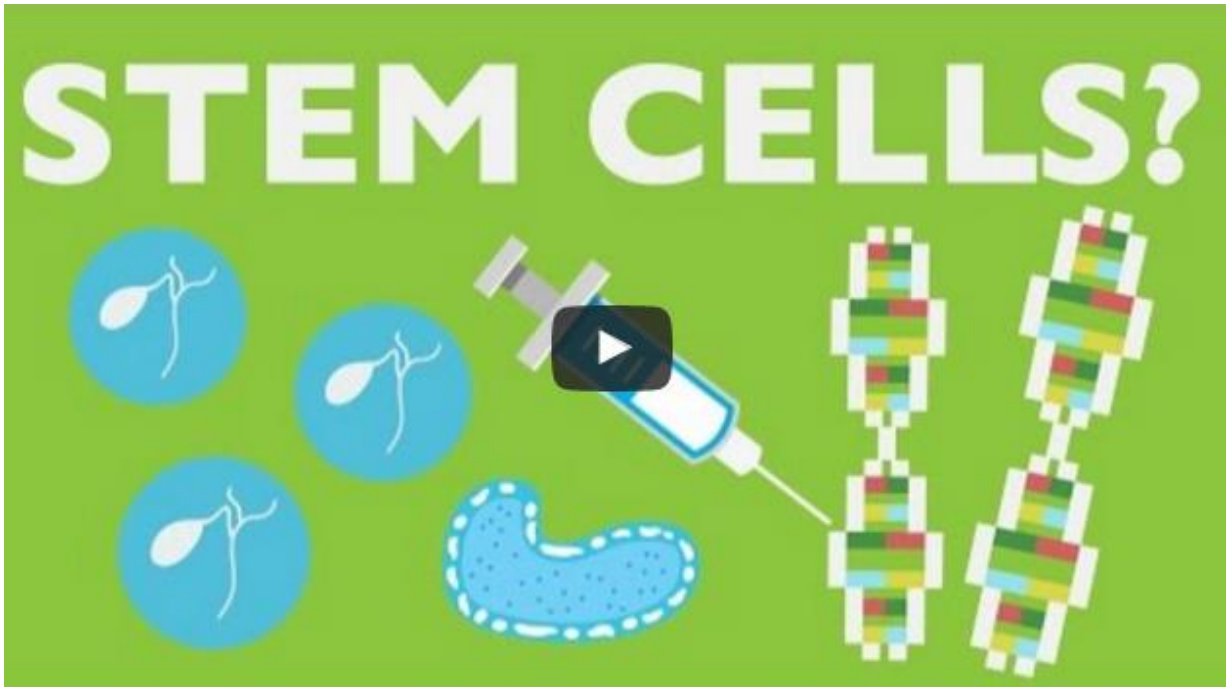
Question 5

Umbilical cord

C) HOW STEM CELLS WORK

Watch the video and complete a "dot point" summary on how stem cells work below:

https://www.youtube.com/watch?v=K7D6iA7bZG0



WHAT CAN STEM CELLS DO? (Source: YouTube, accessed on February 20, 2017)

Question 6

How stem cells work:

D) STEM CELL RESEARCH IN AUSTRALIA

Blood stem cell transplants have been used for many years throughout the world in the treatment of some types of blood cancers.

Australian scientists play a leading role in Stem Cell research, including searching for methods to bioengineer eardrums, heal the brain, treat eye diseases and repair and reverse joint injuries.

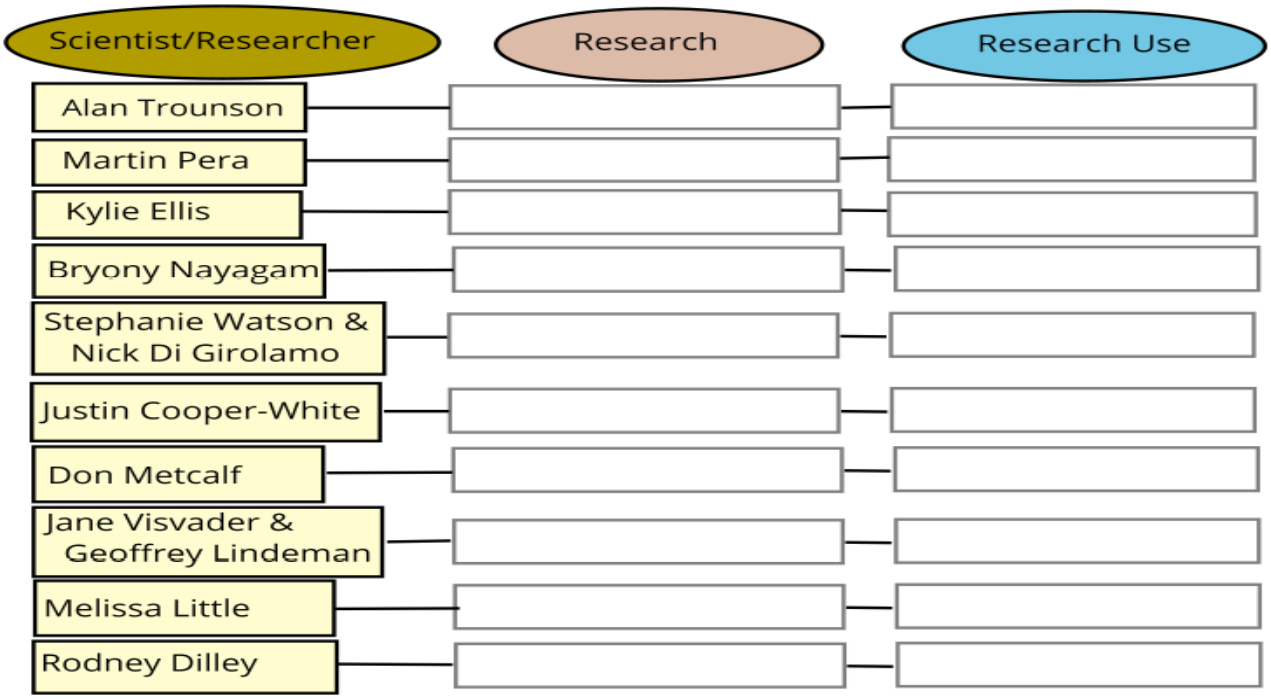
Question 7

Use the website below to match the correct scientist with their research and the area in which the research is used.

http://www.stemcellfoundation.net.au/docs/storybooks/stories-of-australian-stem-cell-science.pdf?sfvrsn=0

Scientist/Researcher	Research	Research Use
Alan Trounson	Min-kidneys	Hearing Loss
Martin Pera	Dental Stem cells	Treatment of stroke
Kylie Ellis	Growth new corneas	Sporting injuries
Bryony Nayagam	CSF	IVF treatment
Stephanie Watson & Nick Di Girolamo	Stem cells in adult brains	Blood cancers
Justin Cooper-White	Breast stem cells	Hearing loss
Don Metcalf	Bionic ears	Breast cancer
Jane Visvader & Geoffey Lindeman	Fertility in Sheep	Alzheimers Disease
Melissa Little	Cartilage repair	Eye disease
Rodney Dilley	Eardrum repair	Kidney disease

Select from the 'Research' and 'Research Use' from the table above and enter in the columns below.



The exercise above probably also highlighted to you that most research is carried out by teams of scientists and researchers. This is the collaborative nature of scientific investigation.

E) CAN I STORE MY STEM CELLS OR THE STEM CELLS OF MY CHILDREN FOR FUTURE USE?

Yes you can!

The Stem Cells in our bodies will not be identical to any other person's stem cells, except for identical twins. This means that should you need a transplant or injection of stem cells, only your stem cells will give a 100% match. You may however need stem cells from a matching donor who has stem cells stored in a public bio bank.

Stem cells can be stored in two types of banks.

a) Public Banking

Donate your baby's cord blood to a government-funded public cord blood bank for use by anyone needing a transplant.

Collection and storage is expensive. Unfortunately, Collection Centres tend not to be located in regional or culturally diverse areas,

leading to low donation rates from ethnic minorities and Indigenous Australians.

b) Private Banking

Pay to store your baby's cord blood and tissue for future individual or family use in a Private Bio Bank.

Activity: Searching a Website

One such Private Bio Bank is Cell Care. You can check out their website below.

Search the Cell Care website to answer the questions below.

https://www.cellcare.com.au/about-cord-banking/cord-blood-and-tissue-basics

Navigate the Cell Care Website to answer the questions below.

Question 8

What is the cost of storing Baby's Cord Blood with Cell Care for 1 year?

Question 9

What is Cord Blood?

Question 10

Why store Cord Tissue?

Question 11

Why are Stem Cells powerful?

Question 12

For how many years can cord blood be stored?

Question 13

Is early or late cord clamping recommended in Australia? Why?

F) THE RISKS

"A number of expensive, unproven and unethical stem cell therapies are being offered in Australia and overseas, often advertised on slick internet sites with glowing testimonials. Alarming reports are emerging, such as bone fragments growing in eyelids after a 'stem cell face lift' or unregulated stem cell transplants causing tumours." (Stem Cell Foundation Australia)

What is your opinion on the use of Stem Cells in future health practices?

(Your teacher will give you a scaffold to prepare your answer).

Question 14

My opinion on Stem Cell Research

In this Unit you learnt about stem cell terms, how stem cells work, where stem cells are stored and the risks involved in stem cell technology. Check you have achieved the Outcomes for this Unit before you move on.

Under the heading below, list some other things you would like to know more about in this Unit

Question 15

I would like to know more about:

5. BIONICS

Bionics is the replacement of body parts or the enhancement of body processes using mechanical or electronic devices. Bionic devices with which you may be familiar are the Cochlea Implant and Artificial limb. But have heard of the "Bionic Eye" or 'Exoskeleton".

A) BIONIC ORGANS AND DEVICES

Watch the YouTube clip "10 Organs Science is Replacing".

https://www.youtube.com/watch?v=5t1dbGVx9Wc

Question 1

Complete "The Bionic Organ" table below.

Bionic Device	Organ Affected	Available Now? Yes or No

Activity: Team PowerPoint Presentation

In groups of 2 or 3, choose one bionic device in the above table. Prepare a 3-minute Power Point Presentation about the device you have chosen.

Your Presentation should include information on,

- The organ affected
- People who will benefit from the bionic device
- The development of the device
- The people involved in the development of the device
- A diagram of the device or an animation on how the device works
- Limitations of the device
- Future developments

Present your information to an audience.

B) THE IMPACT OF TECHNOLOGICAL ADVANCES DEVELOPED IN AUSTRALIA.

Activity: Research the development of either the Cochlea Implant or the Bionic Eye.

Question 2

Which organ did you choose?

Question 3

When was this replacement organ first developed?

Question 4

What technological advances have been made to the organ you chose over the past 3 years?

Question 5

What improvements will be made to the organ in the next 3 years?

Question 6

Name an Australian researcher and an Australian Company involved in the development of the organ you have chosen.

C) THE BIONIC MAN

Activity: Drawing a timeline

Using the information in the diagram below, draw a timeline for the replacement of organs listed.

(https://encrypted-tbn1.gstatic.com/images?q=tbn:ANd9GcRUn4XkPJLgfSp3B63Xx2nkNVNUNm-ZHiLEND3jnI9AzPcuHDvb)

Question 7

Create your timeline below.

D) AN ORGAN IN FOCUS

The Skin

The skin is the largest organ in the human body and an external barrier to infections and environmental particles. The skin also helps to regulate body temperature and contains many nerve endings and blood vessels.

When the skin is seriously damaged through burns, a person may die because the body cannot replace the skin cells quickly enough. It is essential that skin starts replacing itself as soon as possible.

Two Australian Scientists at forefront of research into skin replacement are Doctor Fiona Wood and Marie Stoner.

Activity: Preparing a factsheet

With a partner, prepare a one page factsheet titled 'Artificial skin'. The factsheet should have 8 points and highlight the advancements made by Fiona Wood and Marie Stoner.

Question 8

Attach the Artificial skin factsheet.

Add artificial skin to your organ replacement timeline above.

In this Unit, you learnt about bionic organs and limbs, working as a team member and the future of bionics in medicine. Check you have achieved the Outcomes for this Unit before you move on.

Under the heading below, list some other things you would like to know more about in this Unit

Question 9

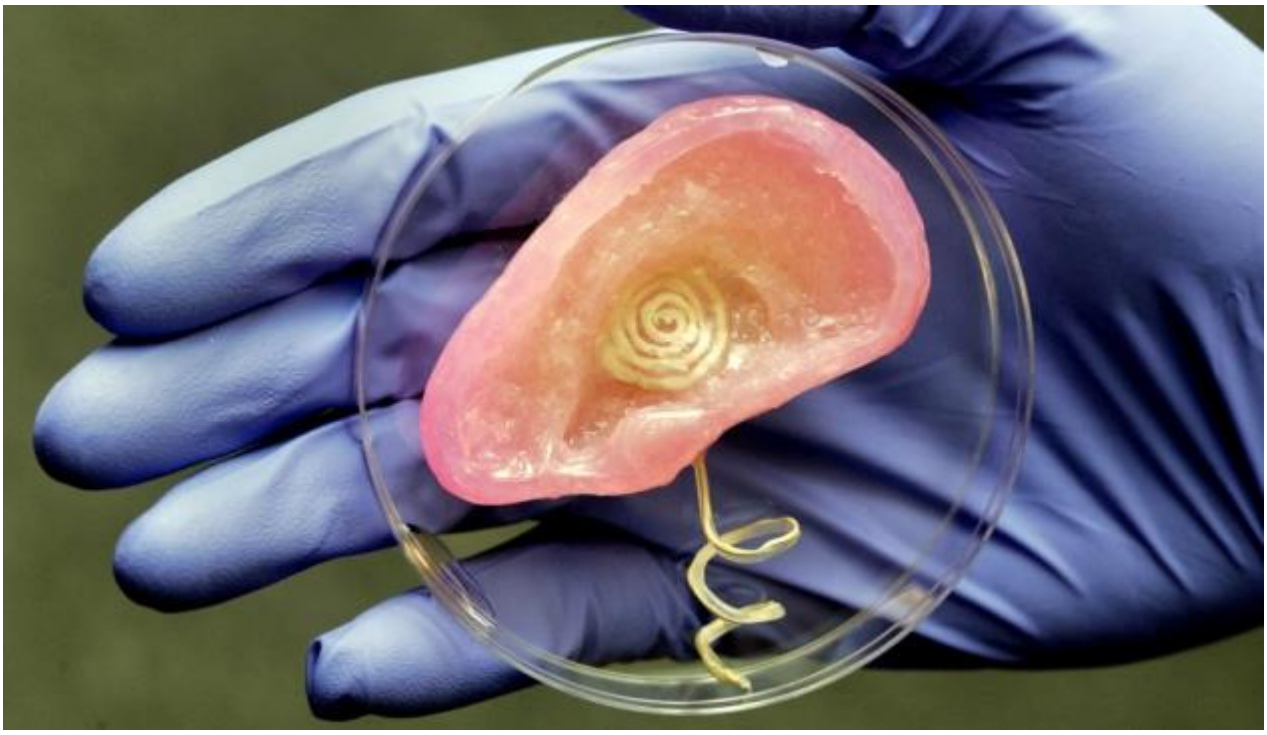
I would like to know more about:

6. PRINTING OF ORGANS AND BODY PARTS

A) THE IMPORTANCE OF TEAMWORK

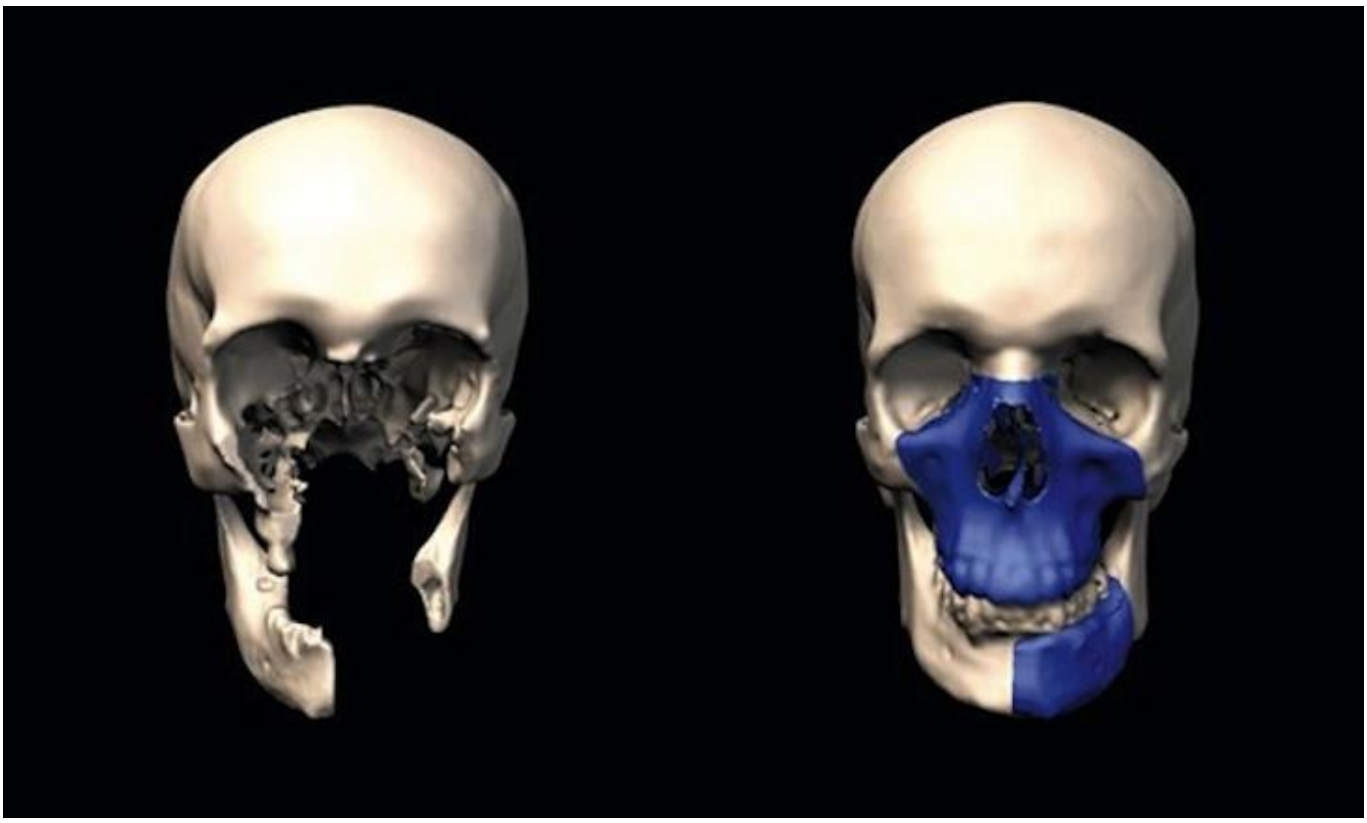
We probably all know someone who has had an organ transplant or received an implant such as a hip replacement. What if these organs, or parts of organs could be 3D printed using living cells as ink? Some of this technology is already available to us and researchers are currently developing new ways to print and replace damaged organs such as ears, skin and heart tissue.

The success of a printed organ requires experts from a range of fields including medicine, engineering, bio-material science, cell biology and physics working collaboratively.



A 3D printed outer ear

(http://www.nature.com/polopoly_fs/7.25315.1429023153!/image/9244_CM_web.jpg_gen/derivatives/landscape_630/9244_CM_web.jpg)



3D Printed facial bones (http://www.3dprinter.net/wp-content/uploads/2012/09/facetranspplant.jpg)

B) HOW CAN 3D PRINTING IMPROVE OUR HEALTH

Watch the videos to enhance your knowledge of 3D printing:

The stuff of Science Fiction?

https://www.youtube.com/watch?v=cMzfyGBfAck

3D Printing helps train doctors

https://www.youtube.com/watch?v=NlsKpVW9uOk

https://www.youtube.com/watch?v=G0B-2Hcg3YI

3D Printing in the Future

https://www.youtube.com/watch?v=cOcL_LPVDB8

https://www.youtube.com/watch?v=YHi2IH2SgJI

C) ORGAN STRUCTURE

In order to 3D print an organ, both the external (outer) structure and internal (inner) structure has to be seen. To help you understand how a 3D printer repeatedly places one layer on top of another to make an exact replica of an organ or body part, complete the following activity.

Activity: Making the Organ

1. Take 3 pieces of different coloured plasticine.
2. Roll one piece into a small cylinder shape about 3cm long.
3. Completely cover this piece with another piece of different coloured plasticine.
4. Finally completely cover this with another piece of different coloured plasticine and shape into ball.

Question 1

Draw the organ, to size, as you see it from the outside. (External Structure)

Activity: Slicing the organ

Slice your organ into 2 halves and look at the internal structure of your organ. You are looking at a cross section of your organ. Imaging

Techniques such as CT Scans (Computed Tomography) produce thousands of body or organ cross sections.

Question 2

Draw a cross section of your organ to exact size. (Internal Structure).

Activity: More slicing

Slice the each half of your organ into 4 more slices. Look at each slice and visualize the internal structure of your organ.

Describe the internal and external structure of your organ below as accurately as you can. (Mention colour, size and shape)

Question 3

Description:

Activity: More teamwork

Compare and discuss your description with another group in your class. When you do this, you are working as part of a team.

Question 4

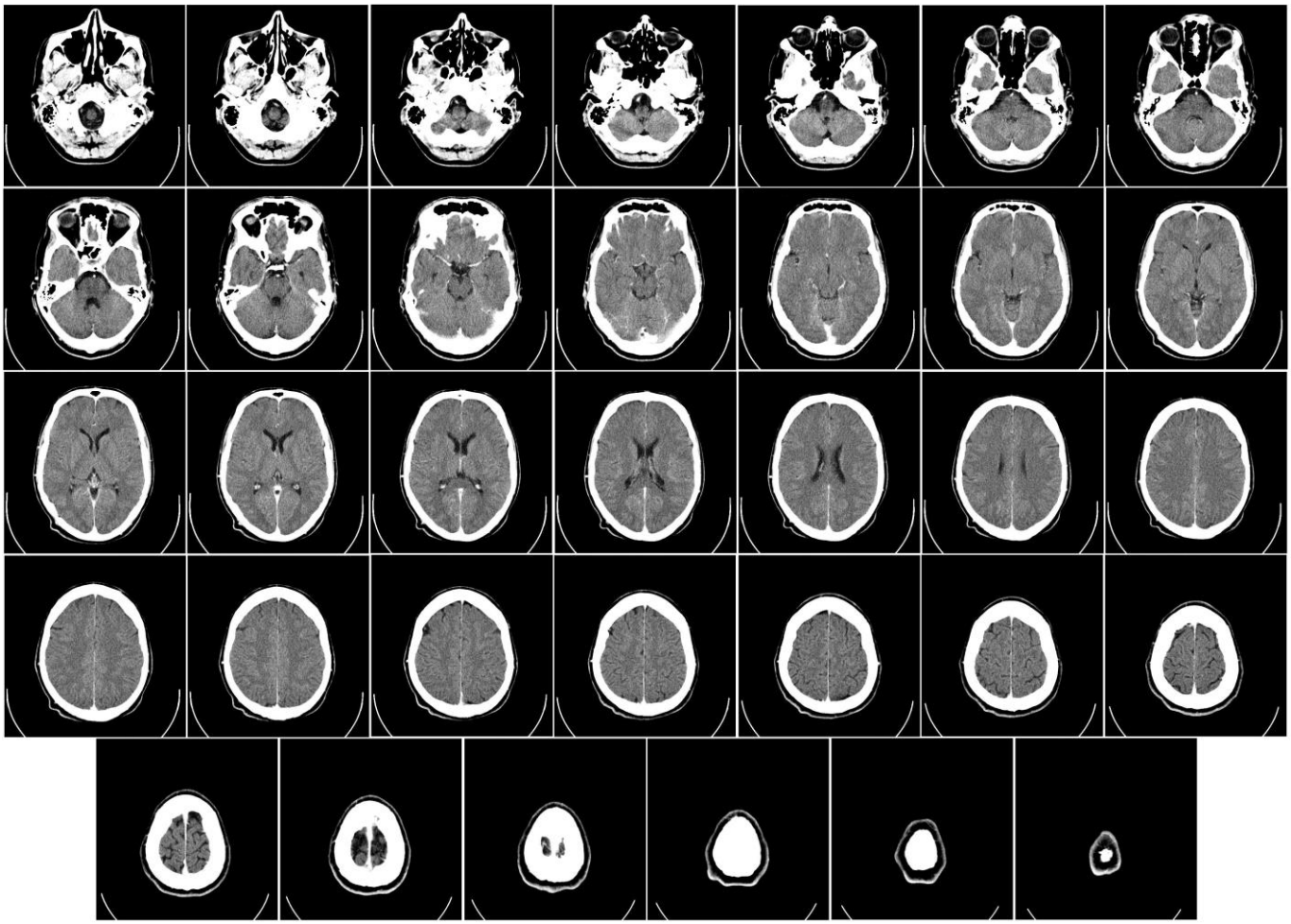
Discussion:

D) LOOKING AT CT SCANS

During a CT scan many X-ray images are taken from different angles. This produces cross-sectional images of the organ being scanned.

Computer processing generates a 3D image of the internal structure of the organ. The obvious benefit is being able to see inside the organ without cutting.

CT scans of a human brain are shown below:



CT scan of a human brain (https://upload.wikimedia.org/wikipedia/commons/5/50/Computed_tomography_of_human_brain_-_large.png)

The combination of many images allows an accurate 3D model of the brain to be printed.

3D Model of a human brain (https://www.research.a-star.edu.sg/cms/figure/index/55e43a4b140ba0db748b46d0)

The application of Technological Advances from a range of areas is essential in improving the way we deal with health problems.

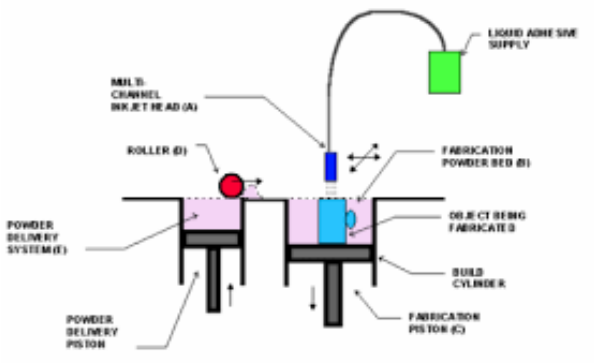
Question 5

How have Physics, Engineering, Biology and Computing Science come together to improve the quality of 3D printed organs?

E) LOOKING AT A 3D PRINTER

Your school or a business in your town may have a 3D Printer. Check out the objects that have been printed. 2D drawings can be enhanced to 3D models using a computer. The model can then be 3D printed using suitable material as ink.

Use the image below to help locate the important parts of a 3D printer. Complete the table as you find each part.



3D Printer (https://encrypted-tbn3.gstatic.com/images?q=tbn:ANd9GcQ5GYmXTP2YZAmfz-bl9GX_TUjYvHuwyDPWr_Wp4yQ9Wqt5j1c--A)

Question 6

Place a Y in the FOUND column when you have located the following parts of a 3D printer.

	Part	Found
1	Powder delivery system	
2	Ink jet	
3	Supporting powder	
4	Roller	
5	Fabrication piston	

In this Unit you learnt how to make cross sections, how to record the results of an experiment and interpret diagrams and how to identify the main parts of a 3D printer. You also learnt about the impact of 3D printing on future health and that successful research comes from the cooperation of experts in a range of fields. Check you have achieved the Outcomes for this Unit before you move on.

Under the heading below, list some other things you would like to know more about in this Unit

Question 7

I would like to know more about:

7. NANOTECHNOLOGY

As you have seen, cells are very small. In the future, we will use nanotechnology to identify unhealthy cells and kill diseased cells without affecting the healthy cells that surround them.

A) SOME POSSIBLE USES OF NANOTECHNOLOGY IN MEDICINE

a) Development of nanoparticles to deliver anti-cancer drugs directly to lymph nodes in the body
b) Inhalable nanoparticle vaccines that can trigger an immune response, eliminating the use of needle injections
c) Nanoparticles which prevent the malaria parasite from spreading to new red blood cells
d) Nanoparticles made into a mesh (Nanofiber), to absorb toxins from the blood. This would be invaluable as a replacement for the expensive dialysis machines currently used to treat people with kidney disease.
e) Nanosensors that can monitor a person's health at a cellular level and warn of impending sickness. For example, nanosensors that monitor glucose level in the blood of people suffering from Diabetes.
f) Nanoparticles that prevent viruses replicating themselves in the bloodstream.

Further uses of Nanotechnology in Medicine can be found from the websites below

http://www.understandingnano.com/medicine.html

https://www.youtube.com/watch?v=x-jyvHS65vo

B) THE SIZE OF THINGS

Nanoparticles are very small. Comparing the size of a nanometer to a metre is like comparing the size of a marble to the Earth. Indeed if you were very small and took nanometer size steps, it would take you about 26 years to walk across a $5 note. Can you tell big from small?

Question 1

Place the objects shown in the Table below in the correct order from Largest to Smallest.

Object	Largest to Smallest
Cell	
Virus	
Atom	
Nucleus	
Kidney	
Water Molecule	

C) THE ELEMENT CARBON

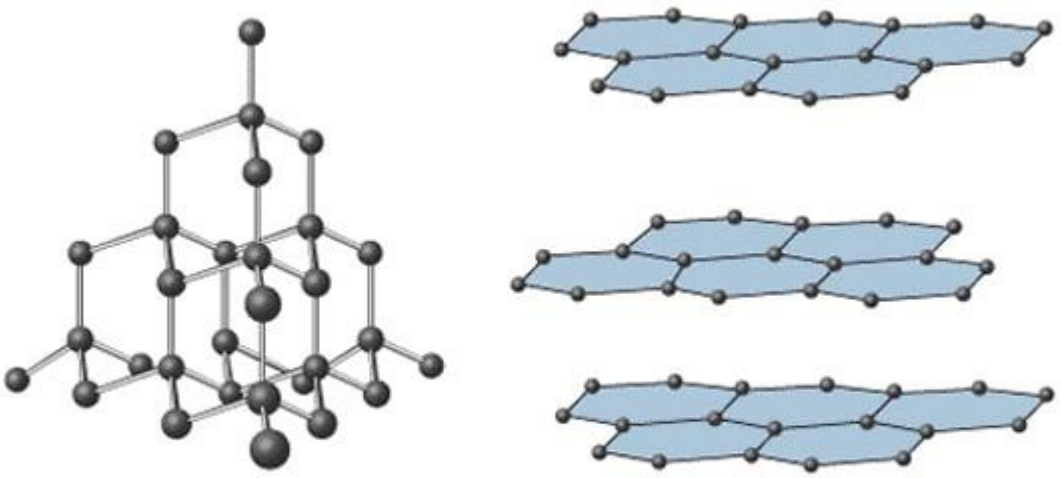
Atoms are the smallest parts of all matter. Substances made up of only one type of atom are called Elements. We will look at the element Carbon and learn how it is particularly useful in medical nanotechnology.

You will be familiar with some natural examples of pure Carbon. Graphite in "lead" pencils and diamonds are two examples. Graphite is very soft while diamond is the hardest known mineral. The different properties of graphite and diamond are due to the different arrangement of Carbon atoms in each.

The diagrams below show the arrangement of atoms in diamond and graphite.

Notice how the atoms of Carbon are organized in layers.

How would you describe the arrangement of Carbon atoms in Diamond?



(a) Diamond (b) Graphite

(http://www.scienceline.ucsb.edu/images/diamond-graph.jpg)

D) BUCKYBALLS AND NANOTUBES

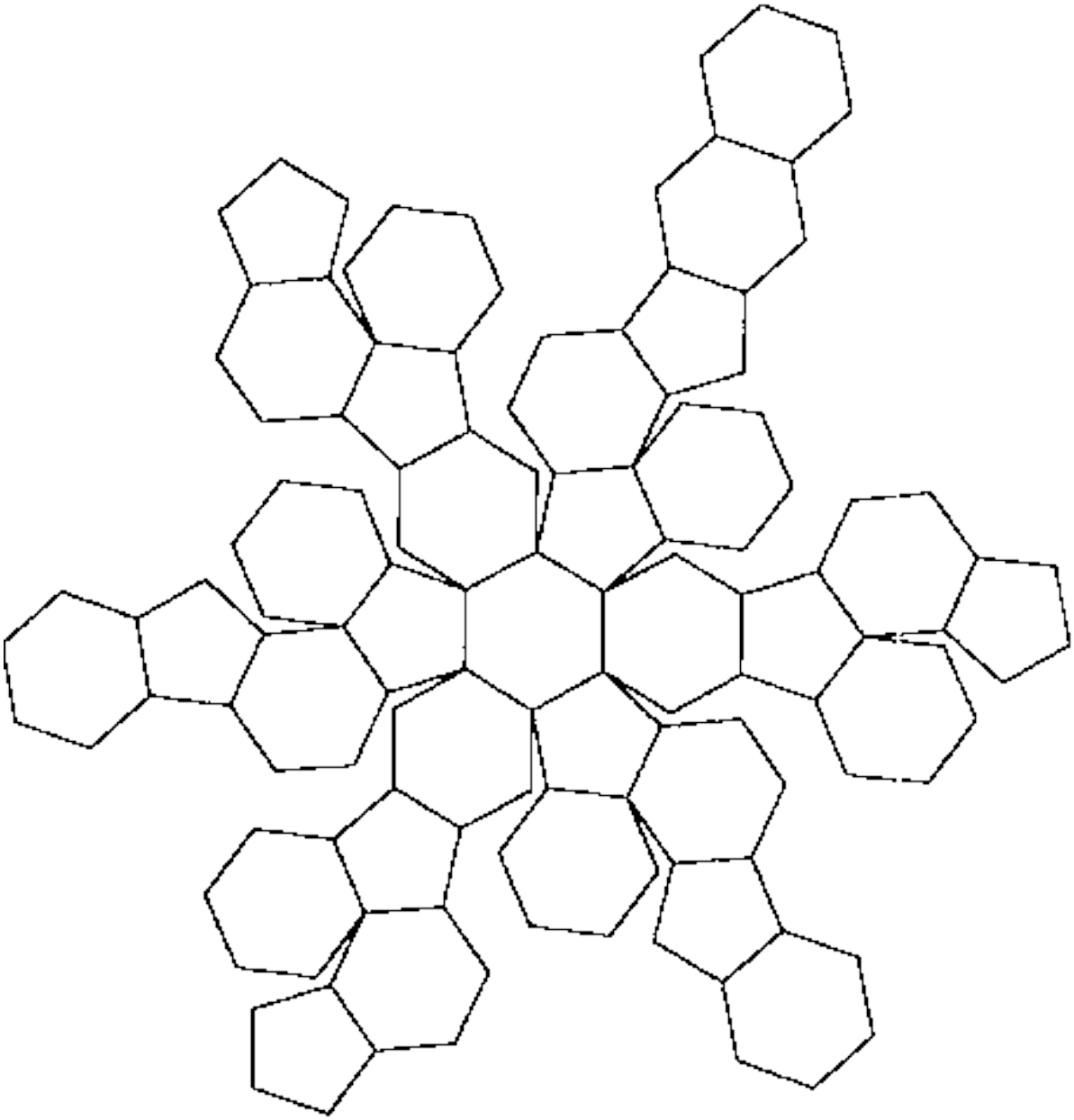
Carbon atoms can also form nanoparticles with different shapes. These nanoparticles can have the shape of mini soccer balls, golf balls and tubes.

These shapes are called buckyballs (or fullerines) and Tubes. They have many uses in medicine including transporting drugs to cells.

They range in size from 1nm to 100nm.

Activity: Building a buckyball

You can build your own model of a buckyball using the template below. Simply cut out the shape and tape the edges together.



Buckyball template (http://mathforum.org/alejandre/workshops/buckyball.net.gif)

Question 2

Describe the shape of your buckyball.

Question 3

Is your buckyball hollow?

Question 4

What things could be transported through the human body in buckyballs?

Question 5

In terms of size, between which two objects would you place a buckyball in the Table in Question 1 above?

E) NANOPARTICLES AS SHIELDS

Nanoparticles are used in a range of manufactured products. One such product is sunscreen.

Research the use of nanoparticles in sunscreens and assess the use of these sunscreens in terms of benefits and risks to health.

Write your assessment under the heading "The Use Of Nanoparticles in Sunscreen" (Your teacher will provide you with a scaffold to help you with your answer).

Some links to get you started are listed below

http://www.sbs.com.au/topics/science/fundamentals/explainer/whats-deal-nanoparticles-sunscreen

http://www.smh.com.au/national/scientists-discover-nanoparticles-in-sunscreen-are-harmless-20140127-31iy4.html

The Use of Nanoparticles in Sunscreen

F) NANOROBOTS

Artificial, non-biological robots in the nanometre realm, are yet to be created. The vision of extremely small bulldozers cleaning the walls of our blood vessels remains in science fiction. If artificial, non-biological nanorobots were to be used in medicine, what would they look like?

Activity: Designing a Medical nanorobot

(Decide on the function of your robot before you design it)

Question 6

What is the function of your nanorobot?

Question 7

Draw your nanorobot below. Label the special features of your nanorobot.

Biological 'robots', such as bacteria and viruses, however can be used to carry drugs to unhealthy cells. Viruses can also be used to carry repair kits inside the nucleus of cells. These "kits" can then interact with a cell's genetic material and change how that cell behaves.

In this Unit you learnt the structure and uses of nanoparticles. Check you have achieved the Outcomes for this Unit before you move on.

Under the heading below, list some other things you would like to know more about in this Unit.

Question 8

I would like to know more about:

8. GENETIC ENGINEERING

Our features, like colour of our eyes, the shape of our ear lobes and whether we have freckles or not, are determined by the DNA in the nucleus of our cells.

Half of our DNA comes from our mother and half from our father, and we each start out life as one cell.

A) SPECIAL GENETIC TERMS

Research the meaning of the special "genetic engineering" terms below:

- DNA
- Genome
- Mutation
- Protein
- Telomere
- Chromosome

Activity: Looking at my features

Question 1

Work in pairs to complete the Table below. Place a (Y) if the feature is present and (N) if the feature is not present.

Feature	I have it Y or N	My partner has it Y or N
Curly Hair		
Freckles		
Blue Eyes		
Detached earlobes		
Tongue roller		
Dimples		
Straight hairline across forehead		
Allergies		
Dimples		
Index finger longer than ringfinger		

Question 2

List the features that you have in common with your partner.

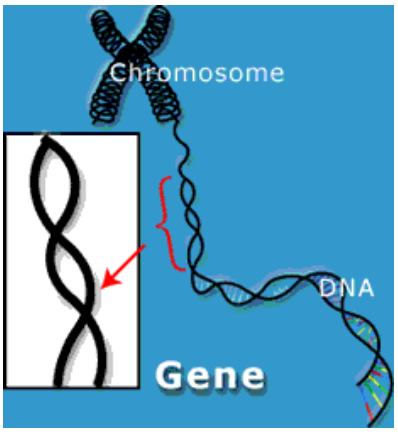
Question 3

List the features that are different in you and your partner.

B) DNA AND GENES

As you can see from the diagram below, genes are sections of DNA. DNA is present in the chromosomes in the nucleus of our cells.

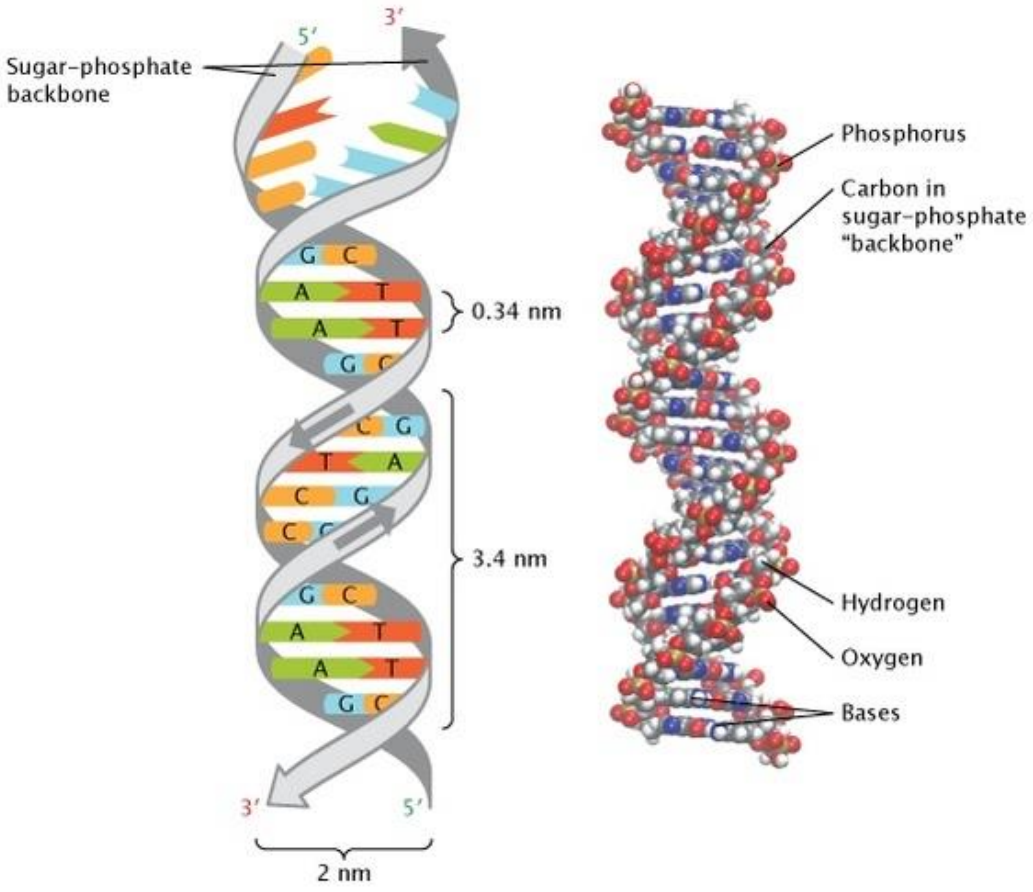
Humans normally have 46 chromosomes.



Genes and chromosomes
(http://www.genomenewsnetwork.org/gnn_images/whats_a_genome/gene.gif)

Genes act as instructions to make molecules called proteins. In humans, genes may vary in size from a few hundred DNA bases to more than 2 million bases.

The diagram below shows the bases that make up DNA.



DNA
(http://www.nature.com/scitable/content/ne0000/ne0000/ne0000/ne0000/104944953/73_1_2.jpg)

These bases are:

Adenine (A)

Thymine (T)

Guanine (G)

Cytosine (C)

Notice that:

Adenine always links with Thymine A-T and

Guanine always links with Cytosine G-C

Reading down the left-hand side of the DNA molecule below gives the sequence GAAGCTCCGAAG. This is a gene sequence made up of 12 bases. It could be part of a much longer sequence. The sequence is specific for making a particular type of protein.

If the sequence is changed, by removing or adding different bases, the sequence will read differently and a different type of protein may be made.

It has been estimated that humans have between 20,000 and 25,000 genes.

What if we were able to alter our DNA and trick it into doing something out of the normal?

Genetic Engineering is the process of changing the gene sequence so that the order of base pairs is different. Since viruses are extremely small and can only replicate inside living cells, they make ideal vehicles in which to carry modified genetic material into cells they invade.

Watch the video "What is Genetic Engineering" to enhance your understanding.

What is Genetic Engineering? (Source: YouTube, accessed on February 20, 2017)

https://www.youtube.com/watch?time_continue=1&v=3IsQ92KiBwM

C) GENETIC ENGINEERING OUTCOMES IN HUMANS

Question 4

In the Table below indicate whether you agree or disagree with the possible outcome of some genetic practises by placing (A) or (D) in the last column.

	Genetic Engineering Outcome	A or D
1	Preventing inherited diseases.	
2	Eliminate Aging.	
3	Producing animals with a similar genetic makeup to humans so that drugs can be tested on them.	
4	Producing clones (exact copies of people) so that replacement organs are readily available.	
5	Genetic testing of potential parents to determine the likelihood of a child being born with a genetic disease.	
6	The process of "gene doping" to produce better athletes.	
7	The ability of parents to choose "designer babies".	
8	Recording each person's DNA.	

D) GENETIC ENGINEERING AND THE FUTURE

How may genetic engineering affect our own future health and the future of humankind?

Watch the video 'Genetic engineering will change everything forever'.

https://www.youtube.com/watch?time_continue=1&v=jAhjPd4uNFY

Genetic Engineering Will Change Everything Forever – CRISPR (Source: YouTube, accessed on February 20, 2017)

Question 5

In a small group, debate the pros and cons of Genetic Engineering.

Write the points of your argument below.

E) GENE THERAPY AND GENETIC ENGINEERING

Research the difference between these two procedures. Include an example of each.

Question 6

Gene therapy and example.

Question 7

Genetic engineering and example.

Question 8

Research the meaning of the word 'ethics'.

Question 9

Why do you think some genetic engineering practices would raise ethical questions?

In this unit, you learnt about DNA, genes and the processes of gene therapy and genetic engineering. Check you have achieved the outcomes for this unit before you move on.

Under the heading below, list some other things you would like to know more about in this unit.

Question 10

I would like to know more about:

9. CAREERS IN FUTURE HEALTH TECHNOLOGY

The list below shows some areas of technology that will have an impact on the quality of future health.

Many scientists from different companies will be working in these fields of research.

Below these questions are websites associated with emerging technologies that will have a big influence on both our individual health and the health of populations. Use these websites to answer the questions.

Choose an area of technology that interests you.

- What is it about this area of technology that you like?
- What is it about this area of technology that you like?
- What subjects would you need to study?
- If you were to choose a career in this area of technology,
- What would be your job description?
- Are there any conferences involving your technology? If so, where and when was the last conference held?
- How will your work influence the future health of individuals and populations?

Artificial intelligence

IBM's Watson Cracks medical mystery

http://www.ibtimes.co.uk/ibms-watson-cracks-medical-mystery-life-saving-diagnosis-patient-who-baffled-doctors-1574963

Virtual Reality

The virtual surgeon

http://www.medicalrealities.com/

Telemedicine and Telehealth

Telemedicine guide

https://evisit.com/what-is-telemedicine/

Hospital robots

Robots roam hallways

https://www.cnet.com/news/robots-give-a-helping-hand-in-san-franciscos-newest-hospital/

Miniature sensors

Stick-on electronic tattoos

https://www.technologyreview.com/s/424989/stick-on-electronic-tattoos/

The human genome project

An overview of the human genome project

https://www.genome.gov/12011238/an-overview-of-the-human-genome-project/

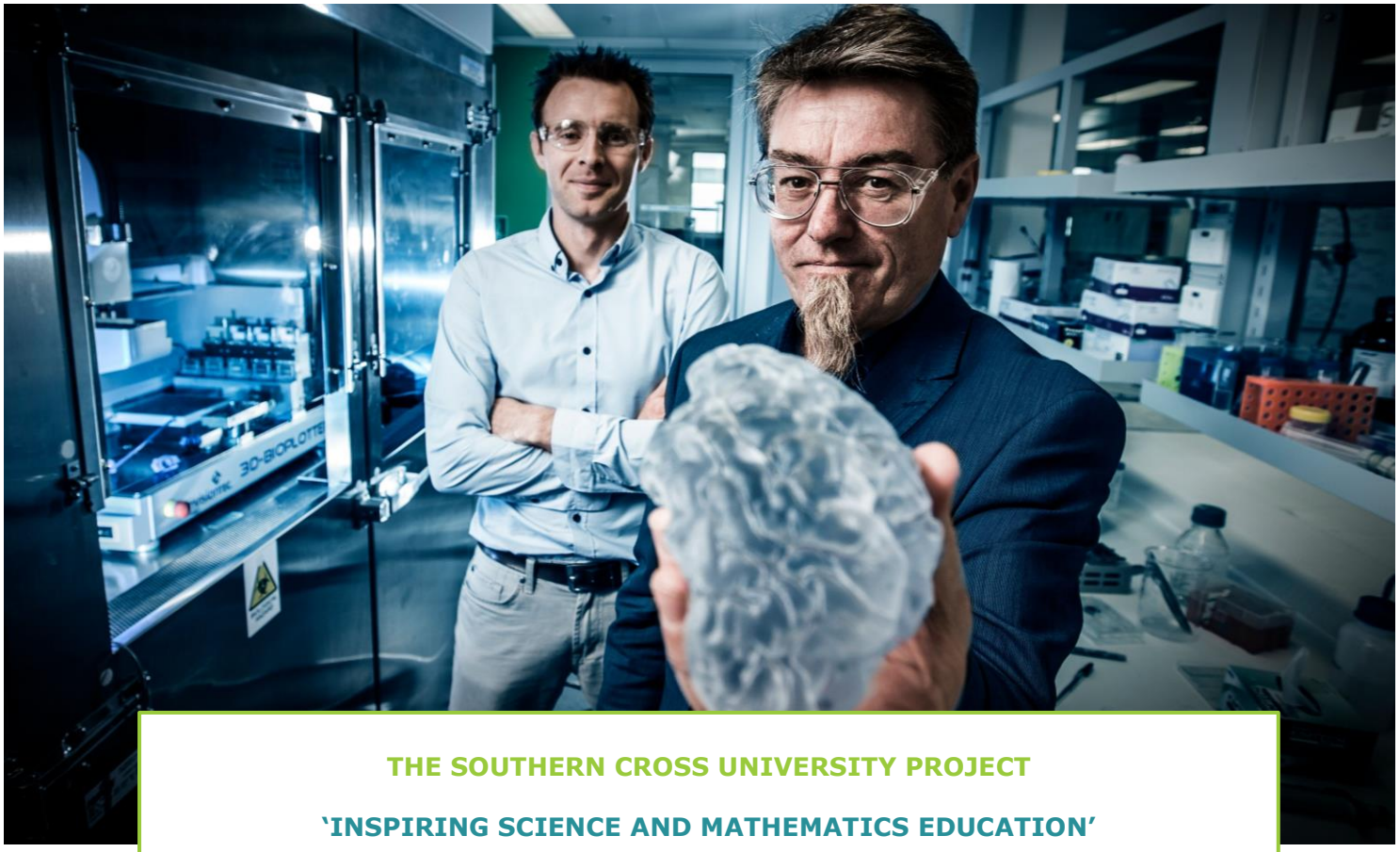
Cyborgs

Robots, cyborgs and cybernetics

https://www.youtube.com/watch?v=cf7B-6XA9VA

GLOSSARY

Term	Meaning



THE SOUTHERN CROSS UNIVERSITY PROJECT

'INSPIRING SCIENCE AND MATHEMATICS EDUCATION'

IS PARTIALLY FUNDED BY THE AUSTRALIAN GOVERNMENT DEPARTMENT OF EDUCATION AND TRAINING THROUGH THE

AUSTRALIAN MATHS AND SCIENCE PARTNERSHIPS PROGRAM

Thank you from our partners

ORICA

The Australian Power Institute

UNIVERSITY OF WOLLONGONG

Southern Cross University

Charles Darwin UNIVERSITY
Innovation in Education

Stile