Chapter 1
Human biological science

Units
1A
1B

Unit content

Approaches to investigating and communicating human biology

- given a relevant contextual research question, use a prescribed format to plan and conduct a safe and ethical investigation
- use simple equipment to collect reliable data presented in simple tables and graphs
- make valid conclusions using appropriate terminology
- provide a list of resources

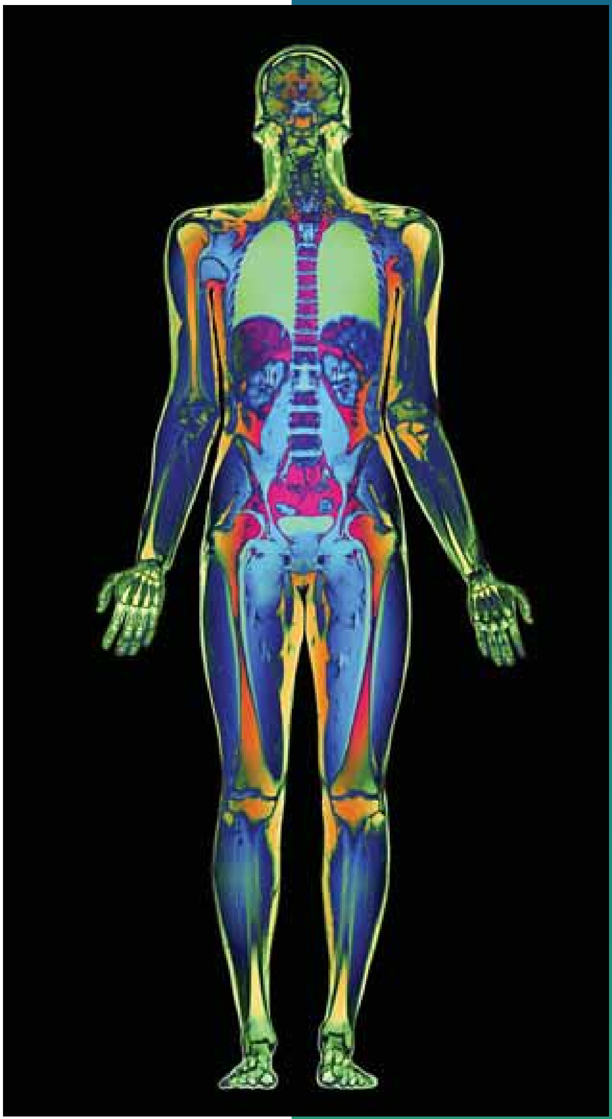


Figure 1.1 A full body scan taken using a MRI (magnetic resonance imaging) machine

If you asked someone what is meant by human biology, they would probably say it is 'the study of the human body'. If you pressed them for more details they may say things like 'finding out how the heart works', 'learning how we digest food', 'studying how we see and hear and taste' or 'observing human cells'. All of those things are a part of human biology but there is much more to it than that.

Human biologists study not just the human body and its workings (see Fig. 1.2). Some other important aspects of human biology involve studying:

- the evolution of the human species: this could include examining fossils or ancient tools, weapons and art
- human behaviour: investigating how humans respond to outside influences and how they interact with each other
- apes, monkeys and other related animals: the way our close relatives in the animal kingdom function and behave can give valuable information about the origins of our own behaviour
- populations: studying the distribution of the human species on the earth and the effect of populations on the environment

Many of these aspects of human biology will be discussed in this book.

Why is human biology important?

Each of us has a body and most of us want to know something about how it works and how to look after it. We are all individuals but none of us can live in isolation; we all have to interact with other people. Most of us are curious. We would like to know the answers to questions such as: Where did the human species come from? What is the future of our species? How can we reduce the risk of disease? How does a person develop from a single fertilised egg cell?

Human biology informs us about ourselves, tries to answer important questions and gives us a background for participating in society. The media constantly bombard us with advertisements for products that are supposed to make us happier, keep us healthy and help us to live longer, more satisfying lives. Human biology gives us knowledge and skills to critically analyse the claims that are made for the products and services we are offered.

There are many issues related to human biology on which there is a wide range of opinion in the Australian community: issues such as abortion, research on human embryos, reproductive technology, organ transplants and the termination of human life. Knowledge and understanding can help us make a meaningful contribution to debate about such issues.

Many careers are related to human biology, such as careers in the various medical fields, food and hospitality, childcare, social work and sport. A study of human biology will help you make a decision about a career. In many cases it will be useful background for further study towards your chosen career.

Human biological science

Like physics, chemistry, geology and others, human biology is a science. **Science** is a word that has two uses. First, it describes the process of discovery that is carried out by scientists—observing, experimenting and studying. Second, science is the *result* of this process—the knowledge that has been discovered about the natural world. This is why the unit content of your human biological science course states that you should learn to do two things:

- explore questions in human biology, collect and present data and use your knowledge for making valid conclusions—this is the process of *doing* science

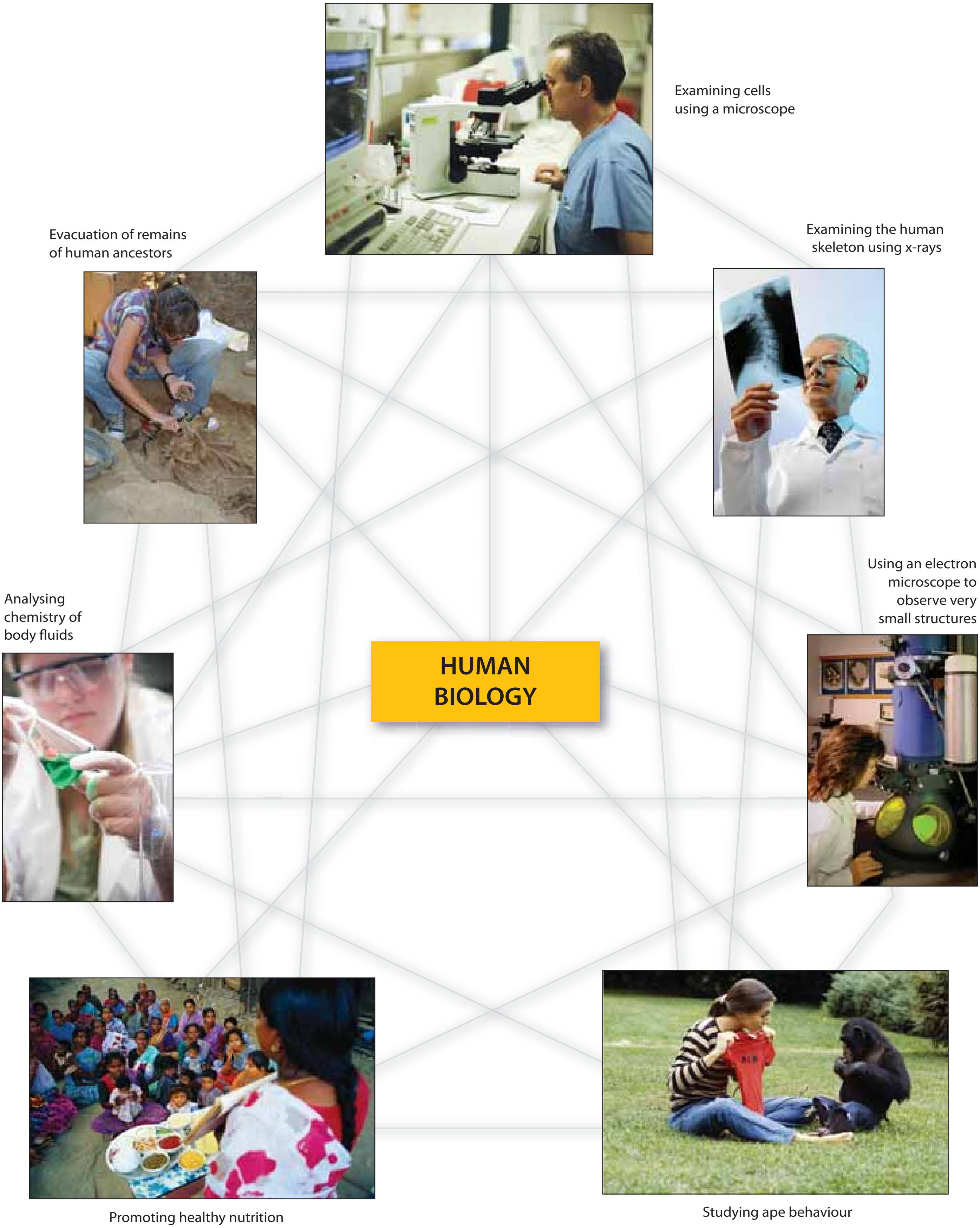


Figure 1.2 Human biologists at work

- understand the structure and function of the human body and mechanisms of reproduction, inheritance and evolution—this is the *knowledge* of the science of human biology.

Scientific knowledge grows as scientists discover more and more. Human biology is an area where there has been an explosion of knowledge in the last twenty years. So that time and effort are not wasted rediscovering things that are already known, scientists communicate their results in journals or at conferences so that other scientists can build on the knowledge. Communication is therefore a very important part of science.

Doing science

You can find out more about the scientific method at http://www.sciencebuddies.org/mentoring/project_scientific_method.shtml

There are many different ways of 'doing science'. Some scientists, like Albert Einstein or Stephen Hawking, are thinkers. They read the evidence collected by others and reason out the solutions to problems. Other scientists are observers. Jane Goodall, for example, spent more than forty years observing the behaviour of chimpanzees at Gombe, in Africa. Many scientists are experimenters. They test their ideas by doing carefully designed experiments. Louis Pasteur, who discovered that infectious diseases are caused by micro-organisms, carried out hundreds of experiments. Most scientists do experiments at some time.

How are scientific discoveries made? There is no particular way that a scientific investigation (or experiment) should be carried out, but investigations do tend to follow a pattern known as the **scientific method**. This pattern is shown in Figure 1.3.

Follow the steps in Figure 1.3 as we work through an example.

Suppose Laura noticed that her heart seemed to beat faster after she had drunk a cup of coffee. This observation may have led her to ask: 'Does coffee cause a change in heart rate?' After searching the available references, Laura found no reports of a

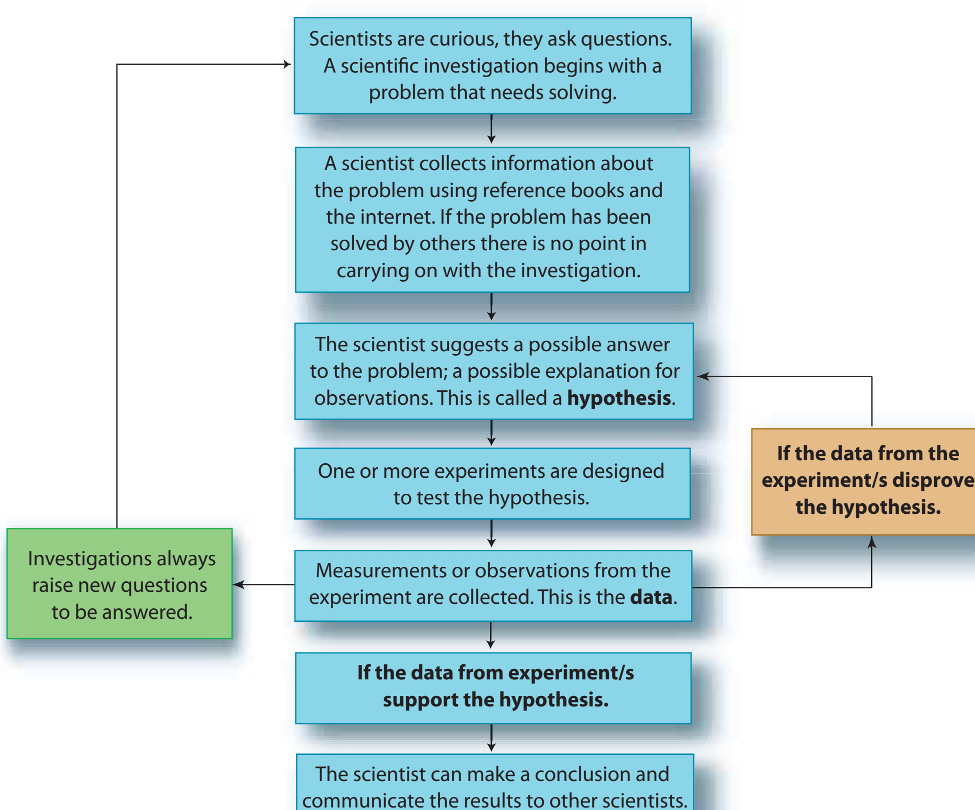


Figure 1.3 The scientific method

relationship between coffee and heart rate. She then proposed the hypothesis: 'That drinking coffee causes an increase in heart rate'. Notice that Laura's hypothesis is simple and easily tested.

The next step would be to design an experiment to test the hypothesis. Laura could measure the heart rates of several people before and after drinking coffee and before and after drinking water. The data she collected would either support or disprove her hypothesis. It is not possible to *prove* a hypothesis. As more and more supporting evidence is collected the hypothesis may eventually be accepted as true but a great many experiments would be required.

If Laura's data supported her hypothesis, she could then draw a conclusion and say: 'It is likely that drinking coffee increases a person's heart rate'. Scientists use phrases like 'it is probable that' or 'it is likely that' because the hypothesis has only been supported by the data, it has not been proved.

If Laura's data showed that heart rate did *not* increase after drinking coffee, her hypothesis would have been disproved. Her conclusion then would be that: 'Drinking coffee does not increase a person's heart rate'. Laura could then make up another hypothesis and design an experiment to test the new hypothesis.

Ethical investigations

An ethical investigation or experiment is one that meets accepted standards. Some of the things that you should consider when you design and conduct an investigation are:

- People participating in an investigation should be volunteers. Nobody should be forced to participate—and if they choose not to be involved, no questions should be asked.
- No harm should come to any person involved in the investigation: think about the health and safety of the subjects, for example, people required to taste substances should not be allergic to any of those substances.
- Participants should be fully informed about what is going to be required of them.
- The privacy of participants should be respected so that any individual's results are not made public.
- No animals should be harmed during the investigation.
- There should be minimal disruption to the environment resulting from the investigation.
- An investigation should conform to all school policies (check with your teacher).
- Communications about the investigation should acknowledge any sources of information or assistance received.
- Resources should be chosen wisely so that they are conserved and, if possible, recycled.

Designing experiments

The design of an experiment is very important because the results of the experiment must either support or disprove the hypothesis that is being tested. Laura's hypothesis was: 'That drinking coffee causes an increase in heart rate'. In this hypothesis, two things can change:

- the liquid that is drunk
- the heart rate.

Factors that change, or vary, during an experiment are called **variables**.

To test her hypothesis, Laura designed an experiment in which some people drank coffee, while others drank water. The heart rate of both sets of people was measured before and after drinking. Laura deliberately changed the type of liquid that people drank. The variable that is deliberately changed is called the **independent variable** or the **experimental variable**.

The variable that changes because of changes in the independent variable is called the **dependent variable**. In Laura's experiment the dependent variable was the heart rate, which she measured before and after drinking the liquid.

Laura had two groups of people in her experiment. One group drank coffee; this is called the **experimental group**. The other group drank water; this is known as the **control group**. Without a control the experiment would not be a **fair test**. Laura would not know if it was the coffee that was making hearts beat faster because she would have nothing to compare her results with. A **control** is a comparison so that we can see whether changes in the independent variable really do make a difference.

For another look at designing experiments go to http://www.dummies.com/WileyCDA/DummiesArticle/Designing-Experiments-Using-the-Scientific-Method.id-1203.html

There are many other factors that *could* affect heart rate during Laura's experiment: things such as the temperature of the liquid, the volume that was drunk, how quickly the liquid was consumed and what the person was doing before drinking the liquid. You will probably be able to think of others. Laura was investigating the effect of drinking coffee, so all other factors that could affect a person's heart rate must be the same for both groups of people. We call these factors **controlled variables**.

For a fair test Laura would need to have, for both her control group and her experimental group:

- the same volume of liquid
- liquid at the same temperature
- all subjects sitting at rest for five minutes before drinking
- all subjects sitting while drinking and after drinking
- the same type of drinking vessel
- all subjects drinking at about the same speed
- all subjects in the same environment while drinking.

These are the controlled variables. Can you think of any other variables that Laura should control if her experiment is to be a fair test?

When designing an experiment you could use a table like Table 1.1 to help you.

Table 1.1 Variables table for designing experiments

What will I deliberately change?	What will I measure?	What will I keep the same?
This will be your *independent variable*.	This will be your *dependent variable*.	These will be your *controlled variables*.

Repetition

Laura carried out her experiment using a number of subjects in the experimental group and in the control group. All people are different, so if she had used just one person in each group that person may have been unusual in some way. This would have made the result very misleading.

To overcome the possibility of chance factors affecting the results of an experiment, scientists repeat an experiment many times. In Laura's case she used a large number of subjects in each of her groups. This is called **repetition** or **replication**. Repetition increases the **reliability** of the results of an experiment; it increases confidence in the results.

Variables

A *variable* is any factor that may change during an experiment.

The *independent variable* is the factor that is being investigated: the factor that is to be studied and deliberately changed to determine its effect. It is deliberately different between the control and the experimental groups in an experiment. The independent variable may also be called the experimental variable.

The *dependent variable* is the factor that changes in response to the changes made to the independent variable. It is the outcome: the variable that is observed and measured.

Controlled variables are all the other factors that may influence the result of an experiment. They must be kept exactly the same for both the control group and the experimental group in an experiment.

Measurement

Any experiment should be designed so that the results can be measured rather than just described. Measurement reduces the chance of any bias or error. For example, Laura could have observed that drinking coffee increased heart rate and said:

> 'After drinking coffee, people's heart rates increased.'

It would be much better if Laura were able to say:

> 'After drinking coffee, the experimental group's heart rate was an average of fourteen beats per minute higher than the control group that drank water. '

For a quiz and more on the scientific method and the design of experiments go to http://www.biology4kids.com/files/studies_scimethod.html

Reporting results

Each generation of scientists builds on the knowledge that has been gained by others. Communicating what has been discovered is therefore a vital part of science. Results and conclusions should be communicated in ways that are clear and easy to understand.

Tables

A **table** is an organised way of presenting the results of an experiment. Observations may be presented in a table but tables are particularly useful for showing measurements.

When you draw up a table to present the results of an experiment there are certain rules that you should follow:

- Include a title for each table. The title usually states the variables investigated in the experiment.
- Use a ruler for straight lines and use pencil for the grid so that errors can be erased.
- Present data in columns. Often, the data for the independent variable is in the left-hand column and those for the dependent variable in the right-hand column or columns. This is not a definite rule; the most important thing is that the table is easy to read and understand.
- Give each column a heading that names the variable and the units in which it is measured.

Laura could have presented the results of her experiment in a table like Table 1.2.

Table 1.2 Laura's results table

Effect of drinking coffee on heart rate		
	Change in heart rate after drinking 200 mL of liquid (beats/minute)	
Subject	**Coffee**	**Water**
A	+ 9	
B	+ 21	
C	+ 17	
D	+ 10	
E	+ 18	
M		+ 2
N		– 3
O		+ 4
P		+ 3
Q		– 1
Average	+ 15	+ 1

Graphs

Graphs are a good way to present data so that they can be easily understood. A **graph** shows how changes in one variable affect a second variable. For example, if the height of a child was measured every three months for two years, the data could be plotted on a graph. A graph would be much easier to read than a table containing all the measurements. Age (in months) is one variable; it affects the other variable, height. In this case, age is the independent variable. Height is the dependent variable, because the height of the child *depends* on his or her age when measured (the age does not depend on the height of the child). The independent variable is normally plotted on the horizontal axis of a graph and the dependent variable on the vertical axis. Such a graph would look like Figure 1.4.

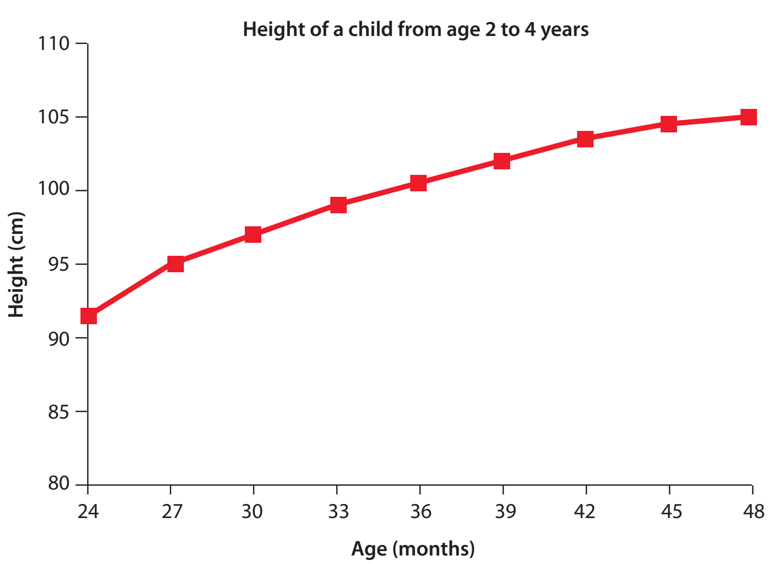


Figure 1.4 Graph showing height of a child from age 2 to 4 years

When drawing a graph it is important to remember to:

- label the axes with the names of the variables
- indicate the units in which each variable is measured
- give the graph a title that summarises the relationship illustrated by the graph
- use equal intervals of units on each axis.

Figure 1.4 is a **line graph**, the most commonly used type of graph in science. Other types of graph that you will come across, and may be required to draw, are bar and column graphs, and histograms.

Bar or **column** graphs represent data by rectangles of equal width with spaces between the rectangles. The length of each rectangle indicates the quantity, so the various quantities can be compared easily. Rectangles are drawn horizontally for a bar graph and vertically for a column graph. Figure 1.5 shows a column graph and a bar graph showing the amount of vitamin C in some fruits and vegetables.

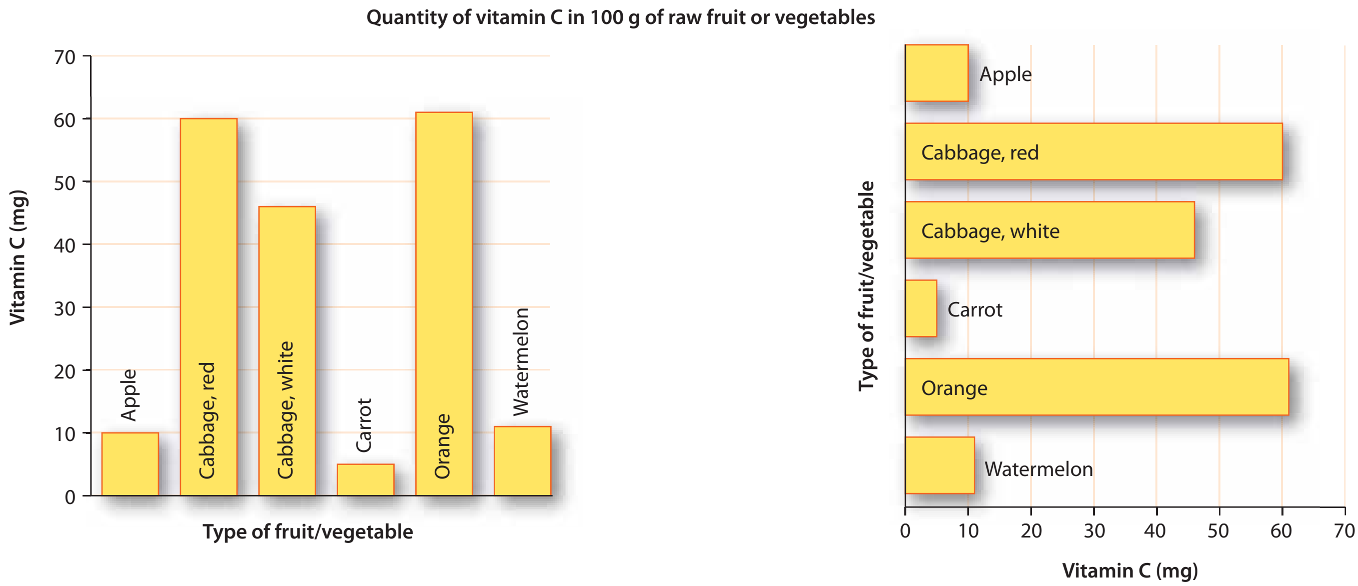


Figure 1.5 A column graph (left) and bar graph (right)

Sometimes data are better represented by a **histogram**. Histograms are often used to show frequencies—how often a particular value or characteristic occurs. They have columns to represent the frequency and the columns are of equal width but there is no space between them. Histograms are particularly useful where data have been grouped into categories to make them more manageable. For example, if one were graphing the number of students in a Year 10 class with heights in the categories 1.20 m to 1.29 m, 1.30 m to 1.39 m and so on, a histogram would be used. Figure 1.6 shows such a histogram.

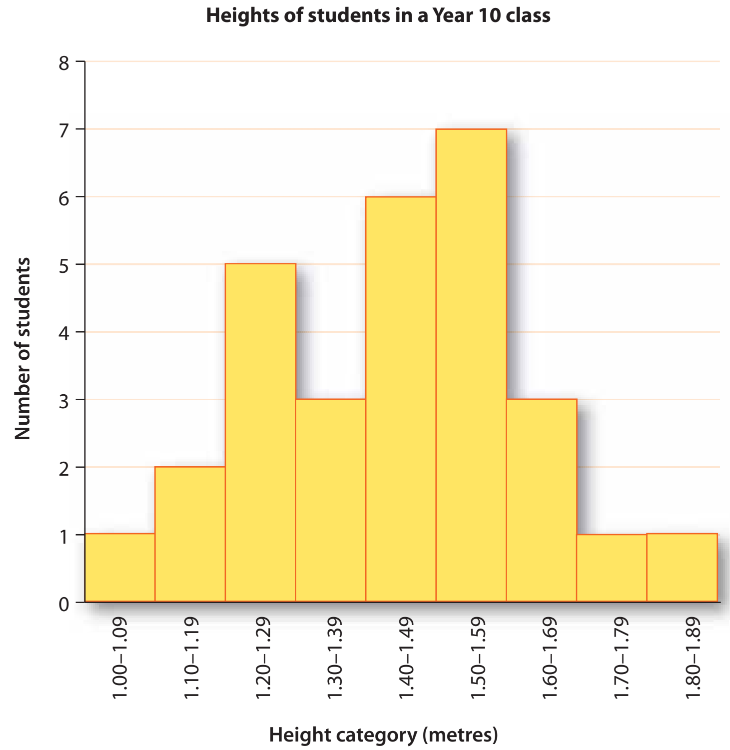
Reports

A **report** includes a description of an investigation, the results that were obtained and any conclusions that can be drawn from the results. Reports are a very important part of communication in science.

The description of how the investigation was done must be sufficiently detailed to allow other scientists to repeat the experiment. It is common practice for scientists to repeat experiments that others have performed. If the results obtained are not the same as those for the original experiment, any conclusions that may originally have been drawn are worthless.

Reports follow a fairly standard format, similar to that described below.

Figure 1.6 A histogram



Report format

Reports may be written using the following headings:

- **title** and name of the author or authors
- **introduction**, stating the nature of the problem and the hypothesis that was tested
- **materials and equipment**, listing the apparatus used, particularly any specialised items of equipment
- **procedure**, describing the method that was used to carry out the investigation
- **results**, often presented as tables, graphs, diagrams or photographs
- **discussion**, including comments about the results and the way they relate to the hypothesis
- **conclusion**, stating whether the hypothesis has been supported or disproved and summarising what can be concluded from the investigation
- **further research**: scientific investigations often raise more questions than they answer—many reports suggest areas that need further investigation
- **references**, a list at the end of the report that include any reports, books or other sources of information that have been referred to
- **acknowledgments** to people who have helped with the investigation, or to organisations that have provided funds for the research.

Listing resources

If an investigation can be repeated and the same, or very similar, results obtained each time, then we can be fairly sure that the results are reliable. Your description should enable other people to repeat your investigation, or experiment, exactly. It is therefore important that you include lists of resources in your description. The resources could be the equipment that you used, the references used to design the experiment or anything else that may have been necessary.

Working scientifically

Activity 1.1 *Hairnu*

Hairnu is a product that claims to stimulate the growth of hair. Figure 1.7 shows an advertisement for *Hairnu*.

Figure 1.7 Advertisement for *Hairnu*

Design an experiment to test the claims that are made for *Hairnu*. In your design make sure that you cover all of the following points.

- State the hypothesis that you are testing.
- What will be your independent variable?
- What will be your dependent variable?
- What variables will you need to control—that is, keep the same for all trials?
- How will you provide a control (comparison) so that you will be able to see whether *Hairnu* does what it is claimed to do?
- How will you measure your results?
- How many people will you need to test to get a reliable result?
- Draw a table to show how you would present your data.
- What results would support your hypothesis? What results would disprove your hypothesis?

Activity 1.2 Investigating human growth rate

A scientist proposed the hypothesis: 'That children brought up on farms have a faster growth rate than those brought up in towns and cities'. Design an experiment to test this hypothesis. List the steps you would take in carrying out your experiment.

Activity 1.3 Testing a hypothesis

A human biologist was testing the following hypothesis: 'That a decrease in environmental temperature causes an increase in the level of hormone X in the blood'.

1. Suggest one prediction that can be made from this hypothesis.

To test the hypothesis, twelve adults were kept in a room (Room 1) at 22°C for twelve hours. The subjects were then transferred to a second room (Room 2) where they were kept for another twelve hours at 10°C. The group consisted of six men and six women, all of the same age. They were fed an identical diet in Rooms 1 and 2. After the twelve hours in each room the level of hormone X in each subject's blood was determined.

2. Why were six men and six women used for the experiment instead of just one of each sex?
3. What was the experimental procedure?
4. What was the control procedure?
5. What was the independent variable?
6. What was the dependent variable?
7. What variables were controlled (according to the description of the experiment)?
8. Can you think of any other variables that should have been controlled? If so, explain why.
9. Do you think the experiment would have been a fair test?
10. What results would have supported the hypothesis?
11. What results would have disproved the hypothesis?

Activity 1.4 Drawing a data table

A student was comparing the reaction times of Year 8 and Year 10 students. A coloured circle was projected on to a screen. As soon as the circle appeared the student being tested had to turn and press the switch on a timing device. These are the data that the student obtained:

Year 10

Robert 1.01 seconds	Fred 0.99 seconds	Amy 1.13 seconds
Jane 0.92 seconds	Li Yo 0.98 seconds	Shehab 1.01 seconds
Ryan 1.09 seconds	Carly 1.07 seconds	Lisa 0.96 seconds

Year 8

Alex 1.12 seconds	Pablo 1.01 seconds	Cameron 0.95 seconds
Lauren 1.06 seconds	Weng 0.93 seconds	Jessica 0.95 seconds
Kate 0.98 seconds	Elaine 1.02 seconds	Holly 1.05 seconds

Draw up a table in which you can show these data clearly.

Activity 1.5 Graphing

1. Draw an appropriate graph to illustrate the data shown in Table 1.3.

Table 1.3 Population of Australian states and territories at the end of March, 2007

State or territory	Population (thousands)
Australian Capital Territory	338.2
New South Wales	6875.7
Northern Territory	213.8
Queensland	4162.0
South Australia	1581.4
Tasmania	492.7
Victoria	5188.1
Western Australia	2094.5

Source: Australian Bureau of Statistics, *Australian Demographic Statistics, Mar 2007*, catalogue no. 3101.0.

2. Some university students measured the amount of oxygen taken into a person's body before, during and after exercise. Their results are shown in Table 1.4. Draw an appropriate graph of the data.

Table 1.4 Oxygen uptake before, during and after exercise

Activity	Time since start (min)	Oxygen uptake (L/min)
Rest	0	0.25
	1	0.25
Exercise	2	1.7
	3	2.8
	4	3.1
	5	3.2
	6	3.1
	7	3.0
Rest	8	2.2
	9	1.4
	10	1.0
	11	0.7
	12	0.6
	13	0.5
	14	0.3
	15	0.25

REVIEW QUESTIONS

1. List and describe some of the areas of study that are involved in the science of human biology.
2. Give reasons why the study of human biological science is important.
3. What is science?
4. Draw a flow chart to show the steps in the scientific method.
5. What is a hypothesis?
6. **(a)** What are variables?
   (b) Explain the difference between the independent and the dependent variable in an experiment.
7. What is the purpose of the control group in an experiment?
8. Why are experiments usually done on a large number of subjects or repeated many times?
9. Why is it preferable to *measure* the results of an experiment rather than just observe any changes?
10. Why do scientists write reports on their experiments?

APPLY YOUR KNOWLEDGE

1. Why are you studying human biological science? What do you hope to gain from your study of the course?
2. Science only deals with things that can be tested. Which of the following statements could be tested scientifically and which could not? Give reasons for each of your answers.
   (a) Australian Rules football is a better sport than cricket.
   (b) Changes in environmental temperature affect urine production.
   (c) Hearing improves with age.
   (d) One should not swear in public.
3. The word malaria comes from two Latin words: *mal* which means bad, and *aria* which means air. The ancient Greeks and Romans believed that malaria was caused by 'bad air' associated with swamps and marshes. We now know that this is not the case.
   (a) Use references to find out the real cause of malaria.
   (b) What were some of the experiments that were done to determine the cause of malaria?
   (c) Which scientists discovered the cause of malaria? How was the discovery communicated to others?
4. Some scientists were testing a new drug called *Presslo*. It was hoped that *Presslo* would reduce blood pressure in people whose blood pressure was too high.

   The scientists selected two groups of people, all of whom were quite healthy but had high blood pressure. All of the people were aged between 50 and 55 years. There were 100 people in each group and each group had equal numbers of males and females.

   One group was given a *Presslo* tablet at 8 am each day. The control group was given a sugar pill at 8 am each day. The blood pressure of the people in both groups was measured and recorded at the same time each day.
   (a) What was the independent variable in this experiment?
   (b) What was the dependent variable in the experiment?
   (c) List four variables that were controlled in the experiment.
   (d) List two variables that were *not* controlled in the experiment.
   (e) What was the purpose of the control group?
   (f) Why did the scientists have so many people in each group?