Level

| F | 1 | 2 | 3 | 4 | 5 | 6 | B6 |
|---|---|---|---|---|---|---|---|



# Scientists – past and present

**Strand**
Science and Society

**Key concept**
Historical and cultural factors influence the nature and direction of science which, in turn, affects the development of society.

## Purpose

Activities in this module are designed to help students understand that ethical, cultural, economic and political considerations influence scientific endeavours. Students have opportunities to:

- access resources to find out how attitudes to science and scientists have changed;
- consider some of the issues facing society today that have a foundation in advances in science;
- reflect on ways in which science is used in the decision-making processes of modern society.

## Overview of activities

The following table shows the activities in the module and the way in which these are organised in **introductory**, **developmental** and **culminating** phases.

| Introductory ► | Developmental ► | Culminating |
|---|---|---|
| Songs and science | Scientists alive | Scientific debate |
| | Women in science | Science in the media |
| | Should development go ahead? | |
| | Making difficult decisions | |
| | Quarantine — protecting Australia | |

QUEENSLAND SCHOOL CURRICULUM COUNCIL

## Core learning outcomes

This module focuses on the following core learning outcomes from the Years 1 to 10 Science Syllabus.

**Science and Society**

5.1 Students consider how and why scientific ideas have changed over time.

**6.1 Students evaluate contributions to the development of scientific ideas made by individuals and groups in the past and present, and consider factors which have assisted or hindered them.**

## Discretionary learning outcome

Activities in this module also focus on the following discretionary learning outcome:

**Science and Society**

**DB6.1** Students discuss the influence of historical, cultural and sociopolitical factors on the resourcing of different areas of scientific research over time.

## Core content

This module incorporates the following core content:

**Science and Society**

**Influential scientists**

- Western, other cultures

**Uses of science**

- influence on Australia, Western influence, other cultures

**Disciplines of science**

- new disciplines and fields, societal imperatives

**The work of scientists**

- ethics, gender, culture, economics, media

**Communication of scientific ideas**

**Changes in scientific ideas over time**

- factors which assist/hinder the development of scientific ideas
- comparison of ideas

# Assessment strategy

Suggestions for gathering information about student learning are provided in each of the activities in this module. Once sufficient information has been collected, judgments can be made about students' demonstrations of outcomes. Typical demonstrations of this module's intended outcomes are provided here to indicate the pattern of behaviour to look for when making judgments.

**Science and Society**

**5.1 Students consider how and why scientific ideas have changed over time.**

Students may:

- discuss the evidence that led to changes in thinking about ideas in science (for example, the organisation of the planets, processes of evolution);
- consider the usefulness of science when making decisions at different points in time;
- reflect on the changes in understanding that result from new or increased information;
- acknowledge the role of the media in transmitting knowledge about science.

**Science and Society**

**6.1 Students evaluate contributions to the development of scientific ideas made by individuals and groups in the past and present, and consider factors which have assisted or hindered them.**

Students may:

- evaluate the influence that the structure of society has on the acceptance of new scientific ideas;
- examine the contribution scientists from diverse cultures in the past and in the present have made to current understandings in science and assess the effects of using science as a tool when making decisions in different situations;
- recognise that information and ideas from many different groups in society affect decision making;
- evaluate the impact of different forms of media on the communication of knowledge about science.

**Science and Society**

**DB6.1 Students discuss the influence of historical, cultural and sociopolitical factors on the resourcing of different areas of scientific research over time.**

Students may:

- recognise some of the factors that determine the nature of scientific research undertaken;
- reflect on the short-term and long-term impacts that some of these factors have on advances in science and applications of the products of scientific research.

# Background information

## Current scientific conceptions

Information about current, relevant scientific conceptions is provided in the resource sheets supplied with this module.

## Students' prior understandings

Students' prior understandings may differ from current scientific conceptions in a range of ways.

Some students may think that:

- science is not influenced by the structures and beliefs of the society in which scientists live;
- science is value free;
- when they read about science in the media they are always getting the 'true' story.



## Terminology

Terms associated with scientific ideas are essential to the activities in this module — for example:

| | |
|---|---|
| cosmology | geocentric |
| environmental impact statement (EIS) | heliocentric |
| evolution by natural selection | quarantine |

Students may already be familiar with some of these terms and understand their meanings and use in scientific contexts. If so, the activities will provide opportunities for them to evaluate current usage. If not, these activities will provide opportunities for students to develop their understandings.

## Strategies for role-play

Role-play is used in activities in this module to encourage students to consider ideas from the points of view of groups of society other than the ones to which they belong. Some strategies have been included here to inform teachers who may not be familiar with this technique.

At the beginning of the role-play there needs to be an agreement that the students will go into role and 'pretend' to be people other than themselves. This could be as simple as a statement such as: 'I would like us to undertake a role-play of (names of role-play). Are you all prepared to do this?'.

Some rules or parameters may need to be set — for example:

- We will listen to each other.
- We agree not to be silly or disruptive.
- We agree to go along with the fiction.

Students will need to be reminded that:

- students adopt the roles of different people involved in the situation;
- students adopt the points of view of the role;
- students do not present their own views.

Students should have a clear outline of a scenario for the role and a clear understanding of the attitude of the character to the situation in the role-play.

- Students who do not have specific roles form the audience and may ask questions. Being in the audience is also adopting a role — a group role.
- Any argument that develops in the role-play is between the roles and not between the individual students.
- Students may use props to help them get into the role.

There need to be signals for 'in' and 'out' of role. For example, badges could be worn (possibly with the names of the characters on them). When the badge is being worn, the person is in role. Taking the badge off indicates that students are out of the roles and are being themselves.

The most important part of a role-play is the debriefing, both with respect to identifying and clarifying what was learned (not just reinforcing previous stereotyped positions) and dealing with any strong emotions.

### School authority policies

Teachers need to be aware of and observe school authority policies that may be relevant to this module.

Safety policies are of particular relevance to the activities that follow. It is essential that demonstrations and student activities are conducted according to procedures developed through appropriate risk assessments at the school.

## Support materials and references

**Songs for use in the activity 'Songs and science'**

'Antarctica' and 'River runs red' from the album *Blue Sky Mining* by Midnight Oil, 1989; and 'Concrete' from the album *Redneck Wonderland* by Midnight Oil, 1988. Available URL: http://www.inf.ufsc.br/~perdigao/oildrop/ (accessed December 2000).

'Nuclear cop' from the album *Virgin Ground*, 1980, and 'Beyond reason' from the album *Frontline* by Redgum, 1985. Available URL: http://freespace.virgin.net/steve.godden/redgum/rgumwords.htm (accessed December 2000). Refer to the database in Redgum Lyrics.

'Saltwater' from the album *Help Yourself* by J. Lennon, M. Spiro and L. Spiro, 1991, Yahoo Geocities Search Engine. Available URL: http://www.geocities.com/Hollywood/Boulevard/2801/saltlyrc.htm (accessed December 2000).

'Where do the children play' by Cat Stevens, 1970, Cat Stevens.com. Available URL: http//www.catstevens.com/lyricstab/index.html (accessed December 2000).

The following websites may be useful for those who wish to search for the lyrics of other songs suitable for the activity:

Sony Music Australia. Available URL: http://www.sonymusic.com.au/artists/ (accessed December 2000).

Virgin Net. Available URL: http://virgin.net/music/index.html (accessed December 2000).

**Evolution**

*Jean-Baptiste de Lamarck*. Available URL: www.kheper.auz.com/gaia/biosphere/evolution/Lamarck.htm (accessed December 2000).

Museum of Palaentology, University of California, Berkeley. Available URL: http://www.ucmp.berkeley.edu/history/evolution.html (accessed December 2000).

*Scientist Heroes.* Available URL: http://www.myhero.com/science/science_content.asp (accessed December 2000). When site has been accessed, select ‘Charles Darwin’.

**Women scientists**

*Distinguished Women of Past and Present*. Available URL: http://www.distinguishedwomen.com (accessed December 2000).

**Information on Maria Winkelmann (Kirch)**

Wertheim, M. 1995, *Pythagoras’ Trousers: God, Physics, and the Gender Wars*, Times Books, a division of Random House, New York.

**Information on Rosalind Franklin**

Appalachian State University. Available URL: http://www.acs.appstate.edu/~farrardg/eagleweb/women/ (accessed December 2000). When site has been accessed, click on ‘franklin.htm’

The Franklin Institute Online. *Woman Power — Rosalind Franklin*. Available URL: http://www.fi.edu/qa98/biology/journals/part1.html (accessed December 2000).

*Who Was Rosalind Franklin?*. Available URL: http://www.suite101.com/article.cfm/women_in_science/3788 (accessed December 2000).

**Information on Barbara McClintock**

Hall, H. 1998, *Great Feuds in Science — 10 of the Liveliest Disputes Ever*, John Wiley, New York.

Kelly, F. 1993, *On the Edge of Discovery — Australian Women in Science*, The Text Publishing Company, Melbourne.

Marine Biological Laboratory. Available URL: http://hermes.mbl.edu/women_of_science/mcclintock.html (accessed December 2000).

The National Academies. Available URL: http://www.nas.edu/history/members/mcclintock.html (accessed December 2000).

**Environmental Impact Statements (EISs)**

Search the Internet using AltaVista and ‘environment+impact+statement’ to bring up a large number of relevant references.

**Futures**

Slaughter, R. 1996, *Futures Tools and Techniques*, Futures Study Centre, Melbourne.

**Transplants**
Australian Kidney Foundation. Available URL: http://www.kidney.org.au (accessed December 2000).

Australian Kidney Foundation 1999, *The Kidney Kit* (a video, teacher background information and classroom activities for Years 5–12). Available from the Australian Kidney Foundation, Floor 4, 133 Leichhardt Street, Spring Hill Q 4001, tel: (07) 3832 2520, fax: (07) 3832 3453 and Education Image Pty Ltd, Floor 1, 176 Bridge Road, Richmond, Vic. 3121, tel: (03) 9429 6299, fax: (03) 9427 0836.

Heart Foundation of Australia. Available URL: http://www.heartfoundation.com.au (accessed December 2000).

News International [search under 'transplants']. Available URL: http://www.thetimes.co.uk (accessed December 2000).

News Limited [search under 'transplants']. Available URL: http://www.news.com.au (accessed December 2000).

The Transplantation Society of Australia and New Zealand. Available URL: http://www.racp.edu.au/tsanz/ (accessed December 2000).

United Network for Organ Sharing. Available URL: http://www.unos.org (accessed December 2000).

The following website has links to many other websites associated with organ and tissue donation and transplantation: http://www.argonet.co.uk/body/lnks.html (accessed December 2000).

Information for students' assignments is also available from Australians Donate, tel: 1800 808 804 (freecall).

**Quarantine**
Australian Quarantine and Inspection Service. Available URL: http://www.affa.gov.au/ (accessed December 2000). When site has been accessed, select 'Quarantine and inspection'.

The Australian Quarantine and Inspection Service has presenters who will visit schools. Contact the Public Relations Officer for Queensland to find out more information and whether visits can be arranged for your area, tel: (07) 3246 8703.

Queensland Department of Primary Industries. Available URL: http://www.dpi.qld.gov.au (accessed December 2000).

**Text analysis**
Queensland Department of Education 1994, *English in Years 1 to 10, Queensland Syllabus Materials: A Guide to Genres in English*, Brisbane.

ACTIVITY

## Songs and science

*Introductory*

### Focus

This activity provides opportunities for students to reflect on issues that had a high public profile in the recent past.

### Materials

- lyrics of songs from the 1970s, 1980s or 1990s with a message about the environment (see p. 5)

### Teaching consideration

Students may suggest songs or poems that could be used for this activity.



### Working scientifically

**Constructing meaning**
**Creating analogies**
**Making links**
**Discussing thinking**
**Retelling and restating**

Time: 30 minutes

▶ Students brainstorm issues in science that they think are currently important to the general public. These could be recorded on butcher's paper or on an overhead transparency for future reference.

▶ Individually or in pairs, students read the lyrics of a selected song or poem to identify the issues it is describing. The identified issues are listed. If songs or poems from a number of decades have been used, students sort the issues into their respective timeframes. They discuss the range of issues identified and any patterns of concerns that emerge. Questions to guide the discussion could include:

- Which issues appear to be common to all the lists?
- Why do you think these issues continue to be of concern?
- Where in the world are these issues relevant?
- What has been done (or is being done) to deal with these issues?
- What should be done?
- Who is responsible for making decisions regarding this issue?
- Which issues are specific to a decade or a point in time?
- How is this issue different in nature (local, more specific, not global) from those that have persisted for decades? What was done (or is being done) to deal with this issue?
- Of which issue were you aware prior to this activity?
- Where did you learn about it?
- What responsibility do you have as an individual (or a member of a group) regarding these issues?

### Gathering information about student learning

Sources of information could include:

- students' analysis of the lyrics or poems and the links made to issues related to science;
- students' contributions to discussions.

ACTIVITY

# Scientists alive

*Developmental*

## Focus

This activity provides opportunities for students to develop an understanding of the impact of social views on the acceptance of new scientific ideas.

## Materials

For the teacher:

- Resource Sheet 1, 'Ideas of evolution'
- Resource Sheet 2, 'Organisation of the planets — geocentric/heliocentric ideas'

For the class:

- library and Internet resources

## Teaching considerations

Resource Sheets 1, 2

Students not familiar with role-play will need some guidelines to follow. These are provided in 'Background information', pp. 4–5. Resource Sheets 1 and 2 provide background information on ideas through time about evolution and the organisation of the planets. Information from these could be used by students or teachers to guide discussion and/or research.

The teacher is the best person to chair the forum, unless there is a class member who has an overview of the ideas of all the characters.

It is not necessary to undertake both Parts 1 and 2. In a large class, however, half the students could undertake Part 1 and the others Part 2.

Students already familiar with Darwin's theories could revisit them in a concept-mapping activity. If Darwin's contribution to ideas of evolution has not been studied previously, research will need to be undertaken beforehand.

## Working scientifically

Time: 60 minutes to gather information and develop the role-play, plus time for presentations

**Collecting information**
**Engaging with problems**
**Making plans**
**Formulating and elaborating ideas**
**Preparing scenarios**
**Arguing a position**
**Improvising and performing**
**Using scientific terminology**

### Part 1

▶ Students create a role-play in which Darwin is explaining his theory of evolution by natural selection to a public forum. At this forum are other scientists, religious leaders and interested members of the general public.

▶ Working in groups of about four, students investigate Darwin's theory of evolution by natural selection. They collect information about the ideas that were accepted at the time and against which Darwin would have to argue. Questions that could guide preparation for the role-play could include:

- What principles support Darwin's theory of evolution by natural selection?
- What evidence did he have to support his ideas?
- What view did Christian churches at the time hold regarding the origin of species and variety within and between species?
- What view regarding the origin of species did most scientists hold?
- Where did power lie — with religious leaders or scientists?

- Who else was thinking and expressing ideas about the origin of species at that time?
- What principles supported their theories and how was their evidence collected?
- How did Darwin make public his ideas?

▶ Students complete the research and then discuss who the characters in the role-play will be. The class divides into groups and each group adopts a role. They then spend some time consolidating their ideas on the position that character would take. One member of the group agrees to play that role. The others form the audience.

▶ The class undertakes the role-play. Students discuss the impact that contemporary society had on the work of Darwin.

**Part 2**

▶ Imagine that Copernicus, Galileo, Brahe and Kepler were all alive at the same time. They have been asked to be the panel at a forum to present their ideas about the organisation of the planets. In the audience are other prominent scientists who believe in Aristotle's view of planetary organisation. Religious leaders of the time and interested members of the general public are also present.

▶ Working in small groups, students research each of the scientists referred to above. Questions that could guide preparation for the role-play could include:

- What ideas did Aristotle, Copernicus, Galileo, Brahe, Kepler have about the organisation of the planets?
- What evidence did each have to support these ideas?
- What other views of planetary organisation and motion were widely held?
- Where did the power lie — with religious leaders or scientists?
- How were the ideas of the scientists accepted at the time?

▶ When this research has been completed, one member of the group agrees to play the role researched by the group. One person acts as the chair for the forum. The others form the audience.

▶ Students discuss the impact society had on the work of these scientists.

**Additional learning**

▶ When both Parts 1 and 2 are undertaken, students could compare the experiences the scientists had in getting their ideas accepted.

### Gathering information about student learning

Sources of information could include:

- students' analysis and synthesis of information;
- students' contributions to the work of the group;
- students' contributions to the role-play as a character or as an active member of the audience.

ACTIVITY

# Women in science

***Developmental***

This activity provides opportunities for students to compare the way that women living in different times have been able to engage in science and the extent to which their work was recognised.

## Materials

- Resource Sheet 3, 'An astronomer before her time'
- websites for Barbara McClintock and Rosalind Franklin (see p. 6)

## Teaching considerations

Resource Sheet 3

Maria Winkelmann lived from 1670 to 1720. She worked alongside her husband and, later, her son and was not accepted as an astronomer in her own right. Information about her life and work is included on Resource Sheet 3.

Rosalind Franklin lived from 1920 to 1958. Her work on X-ray crystallography was instrumental in Watson and Crick's discovery of the structure of DNA.

Barbara McClintock lived from 1902 to 1992. Her research in genetics led to her being awarded a Nobel prize in 1983.

There are many websites with information about the work of Rosalind Franklin and Barbara McClintock. Some of these are listed in the reference section of this module.

Many other scientists could be used instead of the three suggested here. Students may know of scientists they wish to research, or there may be a branch of science of particular interest given the context of the school. Websites with names of female scientists are to be found at http: //www.distinguishedwomen.com

A good source of information would be a female scientist in your area. A scientist would require a few weeks' notice to come to talk to the class. Clear guidelines for the presentation and questions the students would like to ask should be provided beforehand.

## Working scientifically

**Collecting information**
**Formulating questions**
**Seeking reasons**
**Drawing conclusions**
**Making comparisons**
**Discussing thinking**

Time: 90 minutes

▶ Students collect information about the three female scientists and compare their experiences as women working in science. Questions to guide research could include:

- When was ______________ working?
- Which field of science was she working in?
- Was she working on her own or as part of a team?
- What were the main successes of her career?
- What were the major setbacks of her career?
- To what extent did the societal structure of the time influence her career?

▶ Students discuss the information they have collected and identify some of the changes that have taken place. Changes could include access to education, ideas about the intelligence of women, family responsibilities and legal rights.

▶ Students speculate on constraints that influence the careers of female scientists today. They formulate questions to ask a visiting female scientist about her work and her perception of career paths open to her compared with those of male colleagues.

▶ Students participate in the visit of the scientist. They discuss the answers that the scientist provided to their questions and any points of interest arising from the visit.

**Additional learning**

▶ Students ask the visiting scientist (or collect information from other sources) about the constraints that influence scientific research today. These constraints could be independent of gender issues.

### Gathering information about student learning

Sources of information could include:

- students' collection, selection and synthesis of information about the scientists;
- students' participation in class discussions;
- students' contributions to the formulation of questions for the visiting scientist.

ACTIVITY

## Should development go ahead?

***Developmental***

### Focus

This activity provides students with opportunities to consider the views of a variety of stakeholders to a proposed development.

### Materials

For each student:

- Resource Sheet 4, 'New resort in central Queensland'
- Resource Sheet 5, 'Role cards'

### Teaching considerations

Students not familiar with role-play will need some guidelines to follow. These are provided in 'Background information', pp. 4–5.

***Prior understandings***

Students may not be familiar with the concept of an environmental impact statement (EIS). Discuss what an EIS is and who might be involved in its preparation. Published EISs are available on the Internet (see the reference section of this module, p. 6). Reports about controversial developments appear in the press. Some of these reports could provide background information for students.

### Working scientifically

**Engaging with problems**
**Forecasting and backcasting**
**Formulating questions**
**Applying ideas and concepts**
**Dealing in an orderly manner with the parts of a complex whole**
**Formulating and elaborating ideas**
**Looking for alternatives**
**Recognising and analysing options**
**Constructing and using models**
**Discussing thinking**
**Envisioning alternative futures**
**Listening and questioning**
**Responding and debating**

**Resource Sheet 4**

Time: 2 hours

▶ Students set the scene by reading the plan for development of a new resort (Resource Sheet 4).

▶ Acting in the roles of people responsible for the environmental impact statement (EIS), students draw up a table, like the one below, showing:

- the areas of concern;
- possible questions to ask in relation to the statement;
- an expansion of the question indicating aspects of interest or secondary questions;
- the type of scientists who would be involved in finding the answers to these questions.

**Planning an environmental impact statement**

| Area of concern | Question | Expansion | Scientist |
|---|---|---|---|
| Economic impact | Will new roads have to be built? | • Who will pay for the roads?<br>• An improved transport system could bring more people to the area.<br>• … | — |
| Biological environment | Will the eco-tours have an impact on the native grasses? | • How much trampling can the grasses withstand?<br>• The rare grasses could be damaged by the tourists.<br>• Paths could be constructed to prevent damage from walkers. What is the best way of constructing the paths?<br>• … | biologist<br>ecologist — specialist in grassland management |

Resource Sheet 5

▶ Students create a role-play where different interest groups in the community are represented at a local community meeting to discuss issues and concerns related to the proposed resort. Individuals for the role-play could include the shire president; local graziers from adjoining properties; parents; unemployed workers (male and/or female); local shop owner; local tradespeople (builder, plumber, electrician); member(s) of a conservation group(s); a government department officer (for example, from the Department of Primary Industries, Department of Natural Resources). Being a member of the local indigenous community could be incorporated into any of the roles.

Resource Sheet 5 provides suggestions for the characters. Working in pairs or threes, students prepare a character and the scenario for the character to follow. Part of the scenario will be the attitude of the character to the development. One person from each group will take the part of the character. The others will be members of the audience at the public forum.

▶ Students take part in the role-play. They discuss the different points of view that need to be considered when any development takes place. They consider the role that scientific information and scientists can have in the decision-making process.

▶ Students create a futures timeline. They start with the township as it is now and forecast what it would be like in the future (10 or 20 years time) without the development of the resort and what it would be like if the resort went ahead. (For information on futures techniques, refer to *Futures Tools and Techniques*; see p. 6 of the reference section of this module for details.)

### Gathering information about student learning

Sources of information could include:

- students' contributions to the formulation of questions for the environmental impact statement and production of the table;
- students' preparations for and contributions to the role-play;
- students' contributions to discussions;
- students' timelines.

ACTIVITY

# Making difficult decisions

***Developmental***

## Focus

This activity provides opportunities for students to consider some of the issues associated with developments in medicine.

## Materials

For each student:

- Resource Sheet 6, 'Transplant patients'

For the teacher:

- Resource Sheet 7, 'Transplants'
- Resource Sheet 8, 'Transplant timelines'

## Teaching considerations

***About the activity***

The process of deciding on a priority of candidates for a heart transplant and the justification for the decision are the most important parts of this activity. There are no right or wrong answers. The activity is designed so that students can reflect on their own values and beliefs. Teachers may like to point out some of the variables to students (general health, career, number of dependants) or the activity may be open-ended. The students could be asked to rank the patients in order of who should be the first to receive the transplant through to the last. Alternatively, the students may decide on only one recipient. Some medical information is provided (smoking habits, alcohol consumption) to help the students examine their values more closely.

Such an activity will need to be handled in a sensitive manner in view of the following possibilities. Students may:

- have parents, friends or relatives who have had transplants or are waiting for them;
- have family experiences of having to make decisions about organ donation;
- have parents, friends or relatives who are smokers, drinkers or have other lifestyle factors that may be viewed negatively in the prioritising process;
- have friends or relatives who have had unsuccessful transplants;
- be members of religious groups opposed to transplants.

This activity can be completed with all groups considering the transplant recipient from a teenager's view. Alternatively, groups of students could role-play a health professional or a relative. For example, all members of one group could be doctors, all members of another group could be social workers, and all members of a third group could be relatives or other interested, involved people.

***Prior understandings***

**Resource Sheets 7, 8**

An activity that could be used as an introduction to this one is 'Transplants' in the Level 5 module 'Science now and then'. If students have not considered tissue transplantation previously, they may benefit from some introductory discussion. Resource sheets from the Level 5 module have been included here as Resource Sheets 7 and 8 to provide some background about the procedures.



 

## Working scientifically

Time: 40 minutes

**Clarifying and challenging**
**Engaging with problems**
**Predicting**
**Assessing and reassessing**
**Making comparisons**
**Preparing scenarios**
**Arguing a position**
**Expressing points of view**
**Responding and debating**
**Supporting decisions**

**Resource Sheet 6**

▶ In groups, students make a list on butcher's paper of the issues (or decisions that would have to be made) regarding transplanting human tissues and organs.

▶ Students discuss whether the issues would be different if blood, a kidney or a heart were to be the transplanted tissue or organ.

▶ Students consider the following scenario and question:

> One heart has become available for transplant. Four people who are on the waiting list for transplants are compatible with the donor.
>
> Which of these four should get the heart?

▶ In groups of four to six, students read Resource Sheet 6. They suggest reasons for and against each of the patients being the first to be considered for a heart transplant. As a group, students consider each of the variables and create a priority for the heart transplant patients. After making the decision, students list the reasons for this priority. The final decision and the reasons can be presented on butcher's paper.

▶ Each group presents its reasoning to the class. Students compare and discuss the different decisions and reasoning presented by the groups. Questions to guide discussion could include:

- What were the key factors (variables) that influenced your final decision?
- What emotions, if any, did you feel when the rank order was finished?
- Why was it difficult to prioritise the patients? Would health professionals have difficulty making decisions like this one?
- How convinced were you that your decision was right or did you have some lingering doubts?

### Gathering information about student learning

Sources of information could include:

- students' contributions to discussions;
- students' presentations to the class.

ACTIVITY

## Quarantine — protecting Australia

*Developmental*

### Focus

This activity provides opportunities for students to reflect on the importance of science (in particular, the role of quarantine restrictions) in protecting the island continent of Australia from diseases.

### Materials

- information from the Australian Quarantine and Inspection Service's website (see p. 7)

### Teaching considerations

The Australian Quarantine and Inspection Service (AQIS) has a very important role to play in protecting Australia from animal and plant pests and diseases that are prevalent in other countries. It is responsible for:

- finding safe ways of introducing new varieties of plants and animals to help agricultural industries;
- checking imported material (legal and illegal) for pests and diseases to prevent infected material from entering the country;
- undertaking surveillance of potential threats and alerting authorities when a threat is identified;
- assisting in the identification and treatment of any diseases or pests that could not be prevented from entering Australia.

In the quarantine service, scientists are involved in:

- completing literature searches to find out what scientific research is being undertaken in areas of interest to the service;
- helping develop policies;
- studying seized plant and animal materials to ascertain their risk potential.

About 100 exotic marine organisms have become established in Australian waters since the 1960s. These have entered Australian waters in ballast water or on the hulls of ships. Insects are blown in from the islands to the north of Australia — for example, the mosquito, which carries Japanese encephalitis, is endemic to Papua New Guinea and comes into far north Queensland. Migrating birds may introduce pests as they pass through.

An officer from the Australian Quarantine and Inspection Service could visit the class to talk about his or her work.

Access to the Internet is important for this task.



### Working scientifically

Time: a number of lessons for research and preparation of the presentation

**Collecting information**
**Formulating questions**
**Applying ideas and concepts**
**Recognising and analysing options**
**Synthesising**

▶ Students create a presentation to inform others about an aspect of the work of the quarantine service and its importance to Australia's economy and the health of Australian people, plants and animals. In the presentation students could:

- identify a particular disease or organism that poses some form of threat to Australians;
- describe the disease, or the lifestyle of the organism, showing clearly why it could be a threat to Australian people, animals or plants;

**Creating presentations**
**Describing**
**Using scientific terminology**

- describe the action taken to overcome a problem that has arisen, the science supporting the action and the outcome of the action;
- describe what occurs now to prevent or minimise the problem;
- explain any policies in place (and their importance) to control movement of plants and/or animals into, or out of, Australia;
- identify roles the general public can play to support quarantine protocols.

This is not an exhaustive list of ideas, and not all the ideas are relevant to the following topics.

**Suggested topics for presentations**

- We must keep (foot and mouth disease, Newcastle disease, rabies) out of Australia.
- Papaya fruit fly — where did it come from?
- The progression of the black-striped mussel.
- Why I should not take it through customs?
- It came in with the ballast water.
- I want to set up a business (breeding European dogs or a nursery to sell Mediterranean plants).
- Moving animals around the world to sporting events.

**Suggestions for presentations**

Students could prepare:

- a pamphlet;
- a booklet;
- a poster;
- a story for young children;
- a feature article for a newspaper.

### Gathering information about student learning

Sources of information could include:

- students' formulations of questions to guide their research;
- students' collection, selection and synthesis of information;
- students' presentations, taking account of the audience and selected format.

ACTIVITY

## Scientific debate

*Culminating*

### Focus

This activity provides students with opportunities to focus their thinking on science as it is now and to look towards the future.

### Materials

- information sources — textbooks, encyclopedias, the Internet

### Teaching considerations

Finding information for these debates will require time and research expertise. This project could be extended over a few weeks with regular times set aside to talk with students about:

- their progress;
- the arguments they are developing;
- future directions for research.

### Working scientifically

**Clarifying and challenging**
**Forecasting and backcasting**
**Formulating questions**
**Analysing**
**Constructing meaning**
**Creating analogies**
**Developing possible, probable and preferred options**
**Formulating and elaborating ideas**
**Reflecting and considering**
**Arguing a position**
**Envisioning alternative futures**
**Exploring and elaborating ideas**
**Responding and debating**
**Using scientific terminology**

Time: 10 minutes to check on progress; 20 minutes for each debate

▶ Groups of eight students prepare to debate one topic. In the group, four students prepare a case for the affirmative; the other four a case for the negative. Of the four, two would then speak in the debate. The others would participate as members of the audience.

▶ Suggested topics include:

- The major issues for science are all in the past.
- The availability of science information on the Internet means that everyone can be an expert.
- Scientists should be held accountable for uses made of their research findings.
- Scientists can find solutions to our environmental problems.
- Science and politics or business should be kept separate.
- Everyone has equal access to a career in science.

### Gathering information about student learning

Sources of information could include:

- students' analysis, synthesis and presentation of information gathered;
- students' presentations of ideas and understandings;
- students' applications of ideas as they respond in the debate.

ACTIVITY

# Science in the media

***Culminating***

## Focus

This activity provides students with opportunities to compare the ways that science information is presented in the media.

## Materials

- reports on issues and events in science from newspapers, magazines, journals, television, the Internet
- Resource Sheet 9, 'Text analysis'

## Teaching considerations

Newspapers, magazines, journals and television cater for a variety of audiences. The approaches taken, and what is considered to be important for inclusion in articles, differ depending on the target audience. Students use text analysis to compare the ways scientific information is constructed for different audiences. Material for comparison could come from the local newspaper, a statewide newspaper (*Courier-Mail*), a national newspaper (*Australian*), news magazines (*Bulletin*, *Ecos*, *Australasian Science*, *New Scientist*, *Scientific American*, science section of *Economist*), academic journals or publications from conservation groups.

Visual media could also be included — for example, television news, science-based programs, nature documentaries.

## Working scientifically

**Analysing**
**Examining and evaluating**
**Generalising**
**Making comparisons**
**Reflecting and considering**
**Describing**
**Summarising and reporting**

**Resource Sheet 9**

Time: depends on the number of reports and their length

▶ Students read or view two or three reports from different sources. These reports could relate to the same or different issues. They analyse the reports using Resource Sheet 9 as a guide. They compare these analyses, identifying what is similar in all the reports.

▶ Students identify any differences in the reports. They discuss reasons for, and impacts of, the differences. Included in the discussion could be:

- intention and audience — to inform the general public, the scientifically aware or others in the same academic field;
- amount of detail presented;
- accuracy of information;
- whether the information allows readers to interpret the information (data) for themselves rather than just accept or reject the writer's interpretation;
- the amount and specificity of the scientific terminology used;
- whether the language is factual, persuasive or emotive;
- the types of diagrams, pictures or graphs used and how they are used.

▶ Students summarise their ideas about the impact that different sources of information available to the general public have on the knowledge about science and its endeavours.

▶ Students discuss their thinking about the impact that public knowledge of science has had. They discuss the future directions of science and developments that are based on advances in science. They create futures wheels to record their ideas.

▶ Students consider the opportunities that scientists in the past had (for example, Aristotle, Copernicus, Galileo, Darwin) to present their ideas and information to the public.

**Gathering information about student learning**

Sources of information could include:

- students' analysis of the reports and discussion of these;
- students' recognition of the similarities and differences between the reports and their discussion of these;
- students' summaries;
- students' contributions to discussions;
- students' futures wheels.

# Ideas of evolution



### Lamarck (1744–1829)

Jean-Baptiste Lamarck was a French biologist. His ideas of evolution were based on surmise. He had no direct evidence to support them. He stated two 'laws' that he thought governed evolution:

- Organs improve with repeated use and are weakened by disuse.
- Environmentally determined acquisitions or losses of organs are passed on and preserved through reproduction of new individuals.

By the 1930s most geneticists had discredited Lamarck's ideas. However, Lysenko, a Russian scientist, used Lamarck's theories in a failed attempt to improve productivity in the agricultural sector. Lamarckism dominated Russian thinking in genetics until the 1960s. In the late 1990s there was renewed interest because of evidence suggesting that there may be some instances of acquired characteristics being passed on.



### Wallace (1823–1913)

Alfred Russel Wallace was an English scientist. He went to the Amazon to collect beetles and other specimens of living things with the intention of 'solving the problem of the origin of species'. He sent a paper back to England, through Darwin, to be forwarded to Sir Charles Lyell. In this paper Wallace described his theory of natural selection. Darwin was amazed when he saw the paper. He had been working along the same lines and recognised that his ideas and Wallace's were very similar. On the advice of eminent scientists of the day, Sir Charles Lyell and Sir Joseph Hooker, Wallace's paper and an abstract of Darwin's views were delivered as a joint paper at the Linnean Society on 1 July 1858. Wallace's ideas were that:

- the food supply determines the rate of reproduction of animals and the average numbers in a population;
- the animals that survive are the healthiest and most vigorous — the weak die.

### Darwin (1809–1882)

Charles Darwin was an English naturalist. In1831 after graduating from Cambridge University, he travelled aboard the HMS *Beagle* as an unpaid naturalist on a scientific expedition. Inspired by Thomas Malthus's ideas on human population growth and by the variety of species that he had seen on his trips, Darwin began to develop his theory. In it he suggests that changes in the environment would, in the long term, cause living things to change to such a degree that they would become new species. In 1844 he wrote an essay outlining his theory and showed it to friends. He intended writing a book about his ideas but did not start writing seriously until 1857. In 1858 he read the work of Wallace and recognised the similarities of their ideas. He published his book, *The Origin of Species,* in 1859. The arguments in

*(continued)*

# Ideas of evolution *(continued)*



Darwin's book were based on three major facts:

- No two individuals of a species are exactly the same.
- Through reproduction, the populations of all living things tend to increase.
- Despite the tendency to increase in numbers, the optimum population of any species stays approximately the same because of the prevailing conditions.

Darwin's ideas challenged Christian doctrines of the time on at least four grounds:

- All living things have their proper place in the world, and this does not change.
- The Bible contains literal truth.
- Humans descended from the first man and woman rather than evolving from ancestral species.
- Every person has a right to life, whether strong or weak.

The feeling of most people was that Darwin's theory of evolution did not leave any place in creation for God.

**Previous ideas**

Scientists prior to Darwin had ideas about evolution.

Lucretius (94?–55? BC) had a general understanding of natural selection and adaptation but did not understand how it happened.

Plato (427?–347 BC), Aristotle (384–322 BC), and Linneaus (1707–1778) all believed in the concept of fixity of species — that is, species are fixed and unchanging.

Henri Buffon (1707–1788), Etienne Sainte Haillaire (1772–1844) and Lamarck (1744–1829) believed that the environment in which an organism lived influenced its characteristics.

Advances in geology in the late 1700s and early 1800s contributed to people's understanding of the history of the Earth and thinking about evolution. Georges Cuvier (1769–1832) did not believe in evolution. He suggested the idea of 'catastrophism' to explain changes in the Earth's history. James Hutton (1726–1797) and Charles Lyell (1797–1875) were proponents of the principle of uniformitarianism (Darwin had a copy of Lyell's book on the topic with him on the HMS *Beagle*).

# Organisation of the planets — geocentric/heliocentric ideas

R2 Resource Sheet 2

**Setting the scene**

The sixth century BC was a time of great change. This was the period when some of the greatest thinkers were living: Buddha in India; Confucius and Lao-tze in China; the Zoroastrians in Persia (Iran); the Ionian philosophers (e.g. Thales, Anaximander and Anaximenes); and Pythagoras in Greece.

The Ionians (from ancient Greece) developed a series of concepts regarding the heavenly bodies. Their descriptions were the first attempt to explain natural phenomena without relating them to supernatural powers. Many different ideas were expressed without any particular one gaining popularity.

Pythagoras (640–546 BC), who was educated in the Ionian tradition, travelled widely in Asia Minor (the area between the Black Sea and the Mediterranean Sea) and Egypt. He founded the Pythagorean Brotherhood, a religious, scientific and political organisation whose members thought the universe could be explained mathematically.

Pythagoras thought that the cosmos was spherical in shape. He believed that the celestial bodies travelled in great circles, outlining the diameters of concentric heavenly spheres. He considered that the sun, Earth, moon and planets revolved around a central fire, a mysterious, purer, more ethereal sun. These teachings became the basis of Plato's ideas many years later.

As people from Europe travelled farther to India and China, they made new observations of the heavens. Herakleides (390–322 BC) considered that:

- the Earth rotated on its own axis;
- stars did not alter positions relative to Earth and each other;
- the planets moved in an irregular fashion with respect to the Earth;
- Venus and Mercury appeared to move regularly around the sun.

Aristarchus (310–230 BC) developed a *heliocentric* view of the universe with the sun at the centre with the Earth and planets revolving around it.

Alternative ideas were developed in different societies in Greece. Plato (427?–347 BC) was part of an alternative group. He lived at a time when the structure of society in classical Greece was disintegrating. Since Plato was not an astronomer, he had confused ideas on cosmology. He thought that the world was a perfect sphere and all movement of heavenly bodies must be in perfect circles. Aristotle (384–322 BC) promoted the idea of perfect circular motion of heavenly bodies with the Earth as the centre (a *geocentric* view of the universe). He made this the basic belief of astronomy even though observations did not support this concept.

Aristotelian physics could be viewed as a pseudo-science based on ideas that appeared to be scientific but that had no supporting evidence. Aristotle's theory used highly sophisticated terminology but lacked logic and could not be used to predict events. The Catholic Church had aligned itself with the Aristotelian model of the cosmos. The influence of the Catholic Church was so strong that any ideas that opposed its doctrines were rejected.

*(continued)*

# Organisation of the planets — geocentric/heliocentric ideas *(continued)*





Copernicus (1473–1543) looked at the cosmos in a different way. He intended his system to be a true picture of the paths of the planets through three-dimensional space. His solution was for the sun to be at the centre. This was a return to the heliocentric view held by Aristarchus. The problem was that, since Copernicus was still thinking in terms of perfect circles, additional circles were required to cater for the idiosyncrasies of the planets' orbits, a model that was no more accurate than those already in existence.

Kepler (1571–1630) aimed to discover the mathematical plan that the Creator had used to determine the precise dimension of the cosmos. To achieve this aim, he required highly accurate astronomical data. For over 20 years Tycho Brahe (1546–1601) had made detailed astronomical observations. He provided Kepler with data for Mars, the planet whose orbit least fitted the circular hypothesis. After five years, Kepler discarded the idea of the circular motion of planets and considered alternative hypotheses. He found that elliptical motions explained the orbit of the planets. Unlike others, he looked for patterns in data rather than making data fit a preconceived idea.

Other scientists did not agree. Three ideas now existed side by side:

- Copernicus's idea that the sun is in the centre and the planets move in perfect spheres around it (heliocentric);
- Kepler's idea of the sun being in the centre but the planets moving in elliptical orbits (heliocentric);
- Aristotle's and the Catholic Church's belief that the Earth was the central point around which the planets and sun orbited (geocentric).

Galileo (1564–1642) used a telescope to look at the heavens. What he found sent shock waves through Europe. Until Galileo's time the sky was thought to contain the sun, moon, five planets and a fixed array of stars. Galileo discovered that Jupiter had four moons orbiting it. It was then recognised that not all the heavenly objects orbited the Earth. This evidence suggested that the ideas of Copernicus were correct and those of Aristotle wrong. Galileo also found that Venus had phases like the Earth's moon. This provided direct evidence that Venus revolved around the sun not the Earth.

Over a 20-year period, Newton (1642–1727) came to the realisation that some kind of force held the planets in orbit around the sun and the moon around the Earth. He demonstrated that the same force caused things to fall to Earth. He called the force *gravity*. The recognition of this force confirmed heliocentrism (the sun-centred view of the cosmos).

### Additional reading

Koestler, A. 1959, *The Sleepwalkers*, Hutchinson, London.

Wertheim, M. 1995, *Pythagoras' Trousers: God, Physics, and the Gender Wars*, Times Books, a division of Random House, New York.

# An astronomer before her time





**Maria Winkelmann**

Of all the female astronomers of the seventeenth century, the most outstanding was Maria Winkelmann (1670–1720). Yet it was precisely Winkelmann's success that would be her undoing. Again, as with Hypatia and Cunitz, Winkelmann was educated by her father; but in addition to this familial support she received advanced training from a local astronomer. At his house she met the man who would become her husband, Germany's leading astronomer, Gottfried Kirch. Winkelmann chose Kirch, a man 30 years older than herself, because she recognised that with him she could continue to pursue her passion for astronomy. At a time when women had no access to scientific equipment on their own, the only way to gain such access was through a man. And she could hardly have selected a more suitable candidate than Kirch. After they were married, he was appointed to the prestigious position of astronomer to the Berlin Academy of Sciences, and for the next decade, until his death, she worked at his side. Throughout the night, husband and wife took turns observing the heavens; while one slept, the other peered through the telescope.

One night during an otherwise routine stint of observation, Winkelmann spotted something that was anything but routine — a new comet. Comets may seem rather mundane today, but in the early eighteenth century they were important news. Waking her husband, Winkelmann alerted him to her discovery and he immediately sent word to the king; but since the report bore Kirch's name, as academy astronomer, everyone assumed the comet was his discovery. Privately, Kirch acknowledged that his wife had the priority, and when the report was reprinted some years later he formally acknowledged the finding as hers. If Maria Winkelmann had been a man, the discovery of a new comet would have ensured her a firm reputation in the astronomical community, and it would have guaranteed her a professional position of her own. Her husband's career was in part based on his discovery of a comet some 20 years earlier, and Tycho Brahe's reputation had been greatly enhanced by his discovery of one in 1577. Winkelmann was denied due credit for her discovery because she was a woman.

The degree to which the astronomical community was resistant to women became all too evident when Kirch died in 1710 and the position of academy astronomer became vacant. Despite the fact that Winkelmann had worked side by side with her husband, performing all the functions he performed, she did not presume to ask for the position of full astronomer. Rather, she petitioned the academy to appoint her and her son as assistant astronomers in charge of calendar making. One of the academy astronomer's primary responsibilities was to produce the official calendar of the German lands, and in the later years of Kirch's life, Winkelmann had taken charge of this task. Although she had been doing the work in question for more than a decade, the academy council rejected her. Nobody questioned her qualifications; the issue was her sex. Academy secretary,

*(continued)*

## An astronomer before her time *(continued)*



Johann Jablonski, set the tone of the ensuing debate when he wrote: 'Already during her husband's lifetime the society was burdened with ridicule because its calendar was prepared by a woman. If she were now to be kept on in such a capacity, mouths would gape even wider'. A woman, then, even a manifestly capable one, was in her very being seen as a threat to the prestige of the fledgling academy.

One of the few people who supported her was academy president Gottfried Leibniz, co-discoverer (with Newton) of calculus, and one of the great physicists of the seventeenth century. In spite of Leibniz's support, the academy refused to accept Winkelmann, and appointed instead an inexperienced man who soon proved incompetent. Ironically, after his death, the position of astronomer was given to Winkelmann's son, and once again she worked as an unofficial and unpaid assistant for the academy. By this time, however, hostility toward her had become intense, and, because she refused to stay in the background when visitors came to the observatory, members of the academy soon demanded she leave the facility altogether. Thus, in the last years of her life, this first-rate astronomer was forced to hide herself at home. Without access to equipment, her astronomical career came to an end.

Maria Winkelmann's fate is symbolic of the collective fate of women in astronomy. Despite their lack of access to higher education, women quickly found ways to participate in the new science, but, as the field institutionalised, they found themselves barred from official positions, and from formal participation in the community. As long as women astronomers stayed at home, assisting male relatives, their presence was tolerated, and even welcomed — for they could be used to perform the meticulous, but routine, calculating work that is essential to much of astronomy. Indeed, throughout the eighteenth and early nineteenth centuries, there was a long list of distinguished 'amateur' women astronomers. Notable among them were Caroline Herschel (1750–1848), who, working with her brother William, helped to found sidereal astronomy; and Nicole de la Brière Lepaute (1723–1788), who, with the mathematician Alexis Clairaut, first calculated the return of Halley's Comet. Although Clairaut originally gave Lepaute full credit for her contribution, he later retracted his acknowledgment, and today he alone is generally given the credit.

# New resort in central Queensland



## Development plan

A proposal has been put forward to build a resort in central Queensland about 300 km from the coast. The resort will eventually cater for 100 guests, and because of its remote location, many of the staff will have to live there during their working week.

The land on which the resort will be built is a cattle station that has very low productivity and has been running at a loss for many years. The owner of the station is in partnership with the developers.

The local township is 150 km from the property. It has a struggling economy. Little money is coming into the town from the surrounding area, and there is little employment for the residents. Very few young people remain in the town after they leave school.

A wide creek with permanent water runs through the property.
A population of platypuses inhabits the creek. As the only permanent water for a considerable distance, many birds and other small native animals use the creek as their source of water. The creek eventually flows into a river system that supplies water to many properties, small towns and a large coastal town before entering the sea.

On the northern boundary of the property is rocky outcrop where the underlying rock and soil are very different from the surrounding area. This area of about 100 ha is protected, and the hope of conservationists is that it will be declared a national park in the near future. It is the only known habitat of a species of lizard and two species of native grasses.

The developers intend to run eco-tours to the protected area and to the creek. It is intended that parts of the creek will be modified and used for recreation — for example, swimming and canoeing. This will probably require a dam to be built.

When the resort is complete, rainwater collected in large underground tanks will be the main source of water. If required, the creek may be used as a supplement. Waste water will be treated on the site and returned to the creek below the recreation area and the sites used for eco-tours.

Solar collectors will be the major source of energy for the resort, and a generator will provide backup.

Your company has been asked to prepare an environmental impact statement for this project. Your task is to decide on the questions that have to be asked to ensure that the potential impact of this resort is fully investigated. Areas that could be considered include economic impacts; water management; rehabilitation of the area after building is complete; biological environment; waste management.

# Role cards



**Shire president** (or member of the town or shire council)
**Concern:** Development and future wealth of the area
**Considerations:**
- Short-term and long-term employment
- More people coming to the area spending money in the town
- Improved transport systems in the area — upgrading of roads, airport for light aircraft
- Possible future development — extension of the resort
- Growth in the area stimulating further growth — more people in the area leading to better facilities in terms of schools, banks, local government offices, medical care

**Local grazier**
**Concern:** Sustainability of the land
**Considerations:**
- Water quality in the creek for the cattle
- Availability of water if the pattern of flow in the creek is altered
- Land prices in the area
- More development placing increased pressure on land and water resources

**Shop owner**
**Concern:** Viability of the shop
**Considerations:**
- Whether people coming into the area will spend money in the local shops or just in the resort
- Whether supplies for the resort will be ordered through local companies or bought in bulk from a major city

**Tradespeople** (electrician, plumber, builder)
**Concern:** Future employment
**Considerations:**
- Whether local tradespeople will be used in building the resort
- Whether local tradespeople will have a role in maintenance of the resort
- Whether tradespeople will be brought in to take over the jobs of the locals

*(continued)*

## Role cards *(continued)*



**Representative of the indigenous community** (This could be a separate role or linked to one of the other roles.)

**Concern:** Various

**Considerations:**

- Refer to any of the other role cards.

**Parent**

**Concern:** Changing social structure

**Considerations:**

- The problems of the city will have an impact on the youth of the area.
- There will be greater chances of employment for the young people, and they will be able to remain in the area.
- Growth in the area could mean better resourced schools and medical facilities.

**Unemployed person**

**Concern:** Future employment

**Considerations:**

- There could be short-term employment while the resort is being built.
- There could be long-term employment as the area develops.
- There could be more variety in types of employment as a different industry comes to the area.
- People could be brought in from outside the region to fill the positions, and no new employment opportunities would be available for local people.

**Conservationist**

**Concern:** Degradation of the area

**Considerations:**

- Poor management of eco-tours could lead to degradation of the protected area. This could reduce the chances of the area being declared a national park.
- The developers would oppose the area behind the resort becoming a national park because of the restrictions this would place on future development.
- Changes to the watercourse (altered flow, addition of treated wastes) will affect the local freshwater habitat. The platypus population could be affected.
- A detailed study of the organisms living in the creek has never been undertaken. The effect of the changes cannot, therefore, be ascertained with confidence.
- Introduction of weed species from the clothing and shoes of tourists
- Biodiversity and habitat could be lost.

*(continued)*

## Role cards *(continued)*



**Government officer** (federal, state or local government — for example, Department of Primary Industries, Department of Natural Resources, Department of Environment and Heritage, Department of Transport)

**Concern:** Sustainability of the land

**Considerations:**

- Availability of water if the pattern of flow in the creek is altered
- Water quality in the creek for the cattle
- Land prices in the area and the effect on the grazing industry and then on the economy
- More development placing increased pressure on land and water resources

# Transplant patients



**Recipient 1**

Recipient 1 is 35 years old, married with three young children. A carpenter who enjoys life, Recipient 1 smokes and consumes large amounts of alcohol. His lifestyle has contributed significantly to the heart condition he now has. A transplant is the only way of treating his problem. Assuming the transplant is successful, Recipient 1 can expect to make a full recovery; but his future health depends on his willingness to change his drinking and smoking habits.

**Recipient 2**

Recipient 2 is 19 years old and is not in a permanent relationship. She does not have any dependants and is her mother's only living relative. She is studying medicine and leads a healthy lifestyle. Recipient 2 had a very severe viral infection 12 months ago and as a result has developed cardio-myopathy. Her health is deteriorating rapidly and without a transplant she may not reach her twentieth birthday. She could be expected to make a full recovery following a successful transplant.

**Recipient 3**

Recipient 3 is a 62-year-old retired widower who doesn't drink or smoke. His father and brother both developed heart problems and died when relatively young. Harold has eaten wisely and exercised to keep fit hoping that his inherited predisposition to heart problems would not become a reality. Unfortunately, he now has serious problems that can be helped only by a transplant. He is the father of four children and the grandfather of ten.

**Recipient 4**

Recipient 4 is a 12-year-old girl who has a younger brother and sister. She was born with a heart defect that cannot be treated. Despite her medical problems, she is achieving well at school. Her heart function and health have continued to decline, and now a transplant is the only way of saving her life. Following a successful transplant, Recipient 4 could be expected to live a normal life for the first time.

# Transplants



Two types of tissues can be transplanted, regenerative tissue and non-regenerative tissue. They can be transplanted in two ways: from a live donor or from a cadaveric donation (that is, from a person who has died).

### Live donations

Regenerative tissue, which includes blood and bone marrow, can be donated by anyone and there are no restrictions on who can receive it. This is the most common type of transplant from a live donor and carries very low risk.

Kidneys, lungs and liver are non-regenerative tissues and the transplant of these is less common although its frequency is increasing. The number of donors restricts the number of transplants and the donors are usually restricted to blood relatives or people who are emotionally linked — for example, husband and wife. High risks for the donor are associated with this type of donation. It involves invasive surgery with its potential for associated problems.

In all transplant situations there needs to be matching of tissue type.

| | |
|---|---|
| Blood | ABO blood group + rh factor + cross-matching to ensure that the recipient does not have antibodies for any antigens in donated tissue. If antibodies are present, the chances of rejection are greatly increased. |
| Platelets | ABO blood group + tissue type compatibility |
| Bone marrow | ABO blood group + tissue type compatibility + cross-matching |
| Kidney | ABO blood group + tissue type compatibility + cross-matching |
| Liver | ABO blood group + size |
| Lungs | ABO blood group + size + cross-matching when antibodies are detected |
| Heart | ABO blood group + size |

### Cadaveric donation

Most people die because their heart stops beating and the circulation of blood and, therefore, oxygen around their body ceases and cannot be restarted. When tissues are starved of oxygen, irreversible changes take place within them that make them unusable for donation. The kidney is the organ least affected by these changes but 40 minutes after circulation has ceased, it can no longer be used. Structural or connective tissues, such as bone, tendon and heart valves, can be recovered in some cases since they are less affected by oxygen deficit than softer tissue.

*(continued)*

## Transplants *(continued)*



Tissues for transplantation usually come from people who have been declared brain dead. This often occurs as a result of head injury or stroke, and the person is in hospital on a ventilator when brain function ceases. The heart can be kept beating, thus maintaining circulation for one to two days following brain death. This provides time for decisions to be made about the organ donation and for recovery of the organ.

Once consent for donation has been given, a national database is searched for recipients who could receive the organ. Blood group, size, tissue type and cross-matching are considered. A delicate surgical procedure ensures that organs are not damaged in any way when removed from the donor. Highly trained technicians collect tissues. Any wounds are closed, and only the tissues for which there are recipients are removed.



### The removal procedure

The removal procedure involves:

- flushing the blood from the organ to prevent it from clotting in the small blood vessels — the presence of clots would prevent the recipient's blood from flowing freely through the organ after transplantation;
- cooling the tissue to 4°C to reduce the metabolic rate;
- giving anticoagulants to the donor;
- giving vasodilators, chemicals that cause the small blood vessels to dilate, thus keeping them open;
- flushing the tissue with cold saline solution to cool it and remove any remaining blood;
- filling any vascular spaces within the tissue with preservatives.

Only after these steps have been completed is the ventilator removed.

The organ is removed and placed in a sterile plastic bag surrounded by a preserving solution. This bag is placed within a second plastic bag and then into an insulated container of ice. The preserving solution surrounding the organ prevents ice burn of the outside layers of tissue and maintains an even temperature distribution throughout the tissue.

There is a limit to the time organs can 'survive' between removal from the donor and once again being supplied with blood — this time by the circulatory system of the recipient. For kidneys the time is 24 hours, for a liver 12–16 hours, a lung 6–8 hours and a heart 4–6 hours. Where the donated organ is the heart, lung or liver, the recipient is prepared for the operation at the same time as the donated organ is being recovered.

*(continued)*

# Transplants *(continued)*



### Implanting an organ

Implantation of an organ may occur in the correct anatomical position (orthotopic) or the organ may be placed in a different part of the body (heterotopic). The heart is usually placed in the correct anatomical position. A transplanted kidney, however, is usually placed low in the abdominal cavity and the recipient often then has two of his or her own plus the donated kidney.

Once the recipient has received the organ, two to three different drugs must be taken:

- steroids;
- antimetabolite to reduce the formation of white blood cells that could cause rejection;
- blocking agents that reduce the interaction of white blood cells.

After the transplant has established, the steroids and, possibly, the antimetabolites may be stopped. Seldom can the recipient stop taking blocking agents.

### Tissues and organs that can be transplanted

Blood, platelets, kidney, liver, lungs, heart, heart *and* lungs, bone, cornea, sclera, heart valves, tendon, ligament.

# Transplant timelines



| Date | Event |
|---|---|
| 18th century | Tissues were grafted in chickens. |
| 19th century | Transplants and grafts were seen as important in the study of physiology and led to an understanding of the endocrine system. |
| 1804 | Skin was successfully grafted from one position on a sheep's back to another. Exchanges of skin between cows and mares were unsuccessful. |
| 1808 | Skin grafts in humans were used to treat ulcers and burns. The skin was taken from another part of the patient's body. |
| 1851 | Blood transfusions took place.<br>By this stage it was recognised that the success of grafts was related to:<br>• the closeness of the relationship between the donor and recipient;<br>• the youth of the donor;<br>• the amount of new vascular tissue that develops in the grafted tissue;<br>• the cooling of the grafted tissue that preserved it by reducing metabolic rate. |
| 1877 | The first corneal graft was attempted. |
| 1893 | Bone grafts were tried. |
| 1880–1900 | Techniques were developed that enabled arteries and veins to be rejoined successfully. |
| 1906 | The first kidney transplant in humans; it was unsuccessful. |
| 1912 | Alexis Carrel was awarded the Nobel prize for his work on vascular surgery and organ transplantation.<br>In the early twentieth century, the anatomy and general function of organs had been established. Almost every type of organ had been transplanted in animals — heart, lungs, intestines, ovary, testis, spleen, thyroid gland. |
| 1902–1914 | Techniques of surgery were perfected.<br>It was recognised that the relationship between donor and recipient influenced survival.<br>• Transplants within the same individual survived several years.<br>• Transplants between individuals of the same species survived several days to several months.<br>• Transplants between individuals from different species survived several hours to several days. |
| 1912–1914 | Application of X-rays was used to prevent the formation of antibodies in the recipient. This could lead to transplantation of organs between individuals of the same species. (It is the antibodies that cause rejection.) |

*(continued)*

## Transplant timelines *(continued)*



| Date | Event |
|---|---|
| 1922–1923 | The process of rejection was described. Genetic factors (such as blood group) and the formation of antibodies were recognised as important influences on whether a transplant would be accepted or rejected. This idea led to cross-matching of tissues. |
| *World War II caused resources to be channelled elsewhere, and there was no further research into transplants.* | |
| 1954 | A kidney was transplanted successfully from a man to his identical twin brother. |
| 1959–1960 | Total body irradiation (exposure to radiation) was used to paralyse the immune system and prevent rejection. Paralysis of the immune system allowed infections to invade the body. |
| 1959 | Successful kidney transplants took place between non-identical twins. |
| 1960 | Successful kidney transplants took place between unrelated people.<br>Immunosuppressant drugs replaced total body irradiation as a means of preventing rejection. To begin with, these were toxic but improved rapidly. |
| 1964–1968 | Donor organs were used from people who had died. |
| 1967 | The use of immunosuppressant drugs, antimetabolites and steroids made kidney transplantation a realistic therapy.<br>The first heart transplant took place. |
| 1969 | The first lung transplant took place. |
| 1970–1972 | A new immunosuppressant — cyclosporin — was developed and trials showed it to be effective. It revolutionised transplantation. The survival rate from transplants has increased from 30 per cent to 70 per cent since cyclosporin was developed. Transplants became a viable form of treatment. |
| *The development of preservation fluids through the 1960s and 1970s meant that more time could elapse between the organ becoming available and the transplant taking place. Recipients could come from more distant centres and better matching could occur.* | |
| 1983 | Liver transplants are seen as a viable treatment for some diseases of the liver. |

# Text analysis

R9 Resource Sheet 9

1. What is the purpose of the article — for example, to inform, to entertain, to persuade, to report or to analyse?
2. What is the type of text or genre — for example, science report, news story, magazine article, advertisement?
3. Who is the author/authority? (Is the author using personal knowledge or a version of someone else's knowledge? Has the information been verified?)
4. Is the tone formal or informal, distant or friendly?
5. Who is the intended audience — for example, the general population, readers of newspapers, scientific community?
6. What is the subject matter — for example, everyday language and content or technical and specialised?
7. What is the medium (newspaper or magazine) and what is the mode (written only or in combination with visuals such as graphs, photographs)?
8. What is the generic structure?
9. Is everyday language used or is it technical?
10. Is the subject specific (Cyclone Tracy) or general (cyclones)?
11. Is the writing authoritative (must, is, will) or cautious (could, possibly)?
12. What visuals are used (diagrams, illustrations, photographs)?

## Generic structure

The following tables outline the structure of some genres commonly used in science to communicate ideas and information.

***Information report***

| | |
|---|---|
| Title | Topic |
| General classification | Can be a definition. |
| Description of features | Can include types such as parts or components and their functions; qualities or properties such as appearance, size and shape, habits or behaviours, and uses if the topic is non-living. Often the whole is described first, then the parts, such as the head, ears, teeth and so on. |

***Discussion***

| | |
|---|---|
| Issue | Can include a preview. |
| Argument/s for | Consists of a point and an elaboration of it with explanation, more details, evidence, examples. |
| Argument/s against | Consists of a point and an elaboration of it with explanation, more details, evidence, examples. |
| Recommendation/s | Can include a summary of the evidence first. |

*(continued)*

# Text analysis *(continued)*



### *Newspaper short news report*

| | |
|---|---|
| Photograph and caption | Presents a point of view which can be the same as, or different from, the written text. |
| Headline | Is abbreviated. |
| Identification of the reporter | Called the by-line. |
| Summary of newsworthy event | Called the introduction or lead.<br>Contains important but brief information such as who, what, when and where. |
| Background events | Can be called the body.<br>Has more details about what happened to whom in what circumstances.<br>Can mention similar incidents. |
| Sources | Are comments by people involved or experts on the subject. |

### *Analytical exposition*

| | |
|---|---|
| Thesis | Consists of an introduction to the topic and a statement of the position of the writer.<br>Previews or outlines the arguments to follow. |
| Argument/s | Consists of the point the writer is making and elaboration of it with explanation, more details, evidence, examples. |
| Restatement | Is a restatement of the writer's position.<br>Can include a brief summary of the main arguments. |

### *Display advertisement*

| |
|---|
| Headline |
| Name of product or service |
| Description of product or service |
| Price of product or service |
| Seller of the product or service |



Source: Queensland Department of Education 1994, *English in Years 1 to 10, Queensland Syllabus Materials: A Guide to Genres in English*, Brisbane.

## Acknowledgments

Grateful acknowledgment is made to the following organisations and people for granting permission to use copyright material:

Queensland Department of Education for material from *English in Years 1 to 10, Queensland Syllabus Materials: A Guide to Genres in English*, Brisbane;

Times Books, a division of Random House, Inc.; Fourth Estate; and Margaret Wertheim for material from *Pythagoras' Trousers: God, Physics, and the Gender Wars*.

**This sourcebook module should be read in conjunction with the following Queensland School Curriculum Council materials:**

***Years 1 to 10 Science Syllabus***

***Years 1 to 10 Science Sourcebook: Guidelines***

***Science Initial In-service Materials***

ISBN 0 7345 2040 9



Any inquiries should be addressed to:
Queensland School Curriculum Council
PO Box 317
Brisbane Albert Street, Q 4002
Australia

Telephone: (07) 3237 0794
Facsimile: (07) 3237 1285
Website: http://www.qscc.qld.edu.au
Email: inquiries@qscc.qld.edu.au

PIP 99303