



# Chapter 4

## Stem cell use

### – now and in the future

#### Teacher background information

Stem cells are already being used to heal a number of disorders in patients around the world. However, whilst there is a lot of attention surrounding the potential of stem cells, in reality, the range of diseases for which there are proven treatments using stem cells is quite small. The only established stem cell therapies are those of the blood system involving transplants of haematopoietic stem cells (usually from bone marrow or with cord blood) to reconstitute the blood and immune system. All other medical procedures involving stem cells are still currently considered 'experimental' or 'unproven'. Within the 'experimental' category, there are some promising clinical trials in the adult stem cell field in areas such as corneal, mesenchymal, skin and cartilage and some embryonic stem cell research is moving closer to clinical trials.

Stem cells were first used in bone marrow transplants, with the first performed in the USA in 1956. Since the late 1990's when embryonic stem cells were discovered in humans, the advances in stem cell science have been rapid. However not all research is looking at specific cellular replacement therapies, much of the work in the field of stem cell science is focused on understanding normal development and disorders of the human body and for toxicology screening (testing new drugs). For example, scientists have been able to grow heart muscle cells in culture from embryonic stem cells. These stem cells actually pulsate in vitro! If a patient had a disorder that affected the function of these cells, scientists could grow these cells and investigate the physiology of the malfunctioning cells and can even test for the effects of new drugs designed to treat the disorder. This means that the treatment for the disorder can be investigated on species specific cells, which diminishes the need for testing the drugs on other animals.

Multipotent stem cells, other than blood stem cells, could potentially aid in the treatment of tissue that cannot regenerate itself. This would be of benefit for spinal cord injuries and injuries to sensory organs, which also have limited repair capabilities. Again, research on these specific cell types can aid scientists in finding treatment options for other disorders, not necessarily just using stem cells themselves to treat the disorder.

#### Purpose

In this chapter students will gain an appreciation for the number of different benefits of stem cells being currently used and also potential uses of stem cells on the horizon.

#### Activity 4.1 What are stem cells currently being used for?


- 4.1.1. When did stem cells start being used? A timeline activity. Using the timeline on the advances in stem cell research, complete this activity.
- 4.1.2. Demystifying stem cell use. What are stem cells really being used for? Complete the activity.

#### Activity 4.2 Uses of stem cells – media review

- Using links to many different media articles, students are to read the article and present their findings to the class.

#### Activity 4.3 Stem cell research assignments

- Teachers can choose from two ready to use assignments on the uses/potential uses of stem cells to treat patients. Marking criteria are also included.



# Activity 4.1

## What are stem cells currently being used for?

### Purpose

The following activities aim to demonstrate to students how stem cells are currently being used in society today. Scientists are using stem cells in three broad areas: for research into normal development and diseases, drug screening and treatment of specific disorders.

### Class time

4.1.1 10–15 minutes, 4.1.2 10–15 minutes

### Resources required

4.1.1 Copy of 'The Stem Cell Discovery Timeline', copy of handout 4.1.1 and 4.1.2.

### Student knowledge outcomes

- To gain an appreciation of how fast science and technology is advancing.
- To appreciate that haematopoietic (blood forming) stem cells from bone marrow and cord blood are currently being used today and bone marrow transplants have been used for the past 50 years.
- To understand that human embryonic stem cell use in treating disorders with proven treatment is not yet possible.
- To appreciate that the field of stem cell research is moving quickly, however the real life applications of non-blood stem cells in cell based therapies are few but growing.
- There is a great deal of stem cell research being conducted all over the world.

### Student skills outcome

Reading comprehension, numeracy, problem solving, reasoning, application of knowledge, evaluation.

### Prior knowledge

- What stem cells are and the types of stem cells.
- Genes code for proteins and proteins help regulate growth and development.

### Common misconceptions

- All stem cell use is for treating diseases.

*Fact: Not true. The majority of work in the field of stem cells centres on research into understanding normal development, progression of diseases and disorders and toxicology screening (testing new drugs).*

- Embryonic stem cells will be able to be used in treatments in the near future.

*Fact: This is unknown. Many embryonic stem cell treatments are a long way away. Apart from haematopoietic stem cell use (blood stem cells from bone marrow and cord blood) many other stem cells therapies being researched but are still unproven and carry with them some risks that must be addressed before therapies using cells derived from ESCs can be used in treat patients.*

### Further Resources

- Overview of current research being done with stem cells: <http://www.stemcellcentre.edu.au/research.aspx>
- NAWBR resource: [http://www.nwabr.org/education/pdfs/STEM\\_CELL\\_PDF/LESSON\\_1.pdf](http://www.nwabr.org/education/pdfs/STEM_CELL_PDF/LESSON_1.pdf)
- Booklet about HLA matching and transplants: <http://www.stanford.edu/dept/HPS/transplant/html/hla.html>

### References

Stem cell discovery timeline: [http://www.stemcellcentre.edu.au/For\\_the\\_Public/FactSheets.aspx](http://www.stemcellcentre.edu.au/For_the_Public/FactSheets.aspx)

National Marrow Donor Program: [http://www.marrow.org/PATIENT/Support\\_Resources/Patient\\_Frequently\\_A/index.html](http://www.marrow.org/PATIENT/Support_Resources/Patient_Frequently_A/index.html)

NIH website: <http://stemcells.nih.gov/info/basics/basics6.asp>

# Activity 4.1.1

## When did stem cells start being used?

### A timeline activity

Students can complete this activity by using 'The stem cell discovery timeline' (available below or at [http://www.stemcellcentre.edu.au/For\\_the\\_Public/FactSheets.aspx](http://www.stemcellcentre.edu.au/For_the_Public/FactSheets.aspx)), to assist them in completing handout 4.1.1.

## Optional Handout 4.1.1 Stem cell discovery timeline





# Handout 4.1.1

## When did stem cells start being used?

### A timeline activity

Using the information presented on 'The stem cell discovery timeline' complete the following tasks.

1. When was the first bone marrow transplant performed and in which country?
2. Would the scientists who performed this transplant have necessarily known which cells in the blood helped cure the patient? Explain.
3. When were embryonic stem cells discovered?
4. How long after starting bone marrow transplants was cord blood transfusions used to treat disease of the blood?
5. How long did it take for scientists to publish work on human embryonic stem cells (hESCs) after embryonic stem cells were first derived from mice?
6. What is the significance of Dolly the sheep?
7. Locate on the time line all references to Somatic Cell Nuclear Transfer (SCNT) and answer the following questions.
  - a. When did scientists first publish findings on SCNT and in which organism?
  - b. How long after Dolly the sheep were the first successful SCNT produced in humans?
8. Another method of reprogramming cells is by inducing a somatic cell to become pluripotent. These cells are called induced pluripotent stem cells (iPS).
  - a. In which year and in which organism were iPS cells first created and by whom?
  - b. What year was news of the creation of human iPS cells published?
  - c. How many years did it take for scientists to move from non-human iPS to the creation of disease specific iPS cells in humans?
9. What are MSCs?
  - a. Are MSCs embryonic stem cells or tissue stem cells?
  - b. Name three disorders on which are scientist's trialling their use?
10. When did scientists first report the approval to start a clinical trial with human embryonic stem cells and for what purpose?





## Handout 4.1.1

# When did stem cells start being used? A timeline activity – Teacher copy

Using the information presented on 'The stem cell discovery timeline' complete the following tasks.

1. When was the first bone marrow transplant performed and in which country? 1956, USA.
2. Would the scientists who performed this transplant have necessarily known which cells in the blood helped cure the patient? Explain. Not necessarily. Canadian scientists Till and McCulloch only proved the existence of stem cells in bone marrow in 1961.
3. When were embryonic stem cells discovered? 1981 in mice.
4. How long after starting bone marrow transplants was cord blood transfusions used to treat disease of the blood? 32 years. First bone marrow transplant was in 1956 and first cord blood transplant was in 1988.
5. How long did it take for scientists to publish work on human embryonic stem cells (hESCs) after embryonic stem cells were first derived from mice? 17 years. Human embryonic stem cells were first reported in 1998 by Professor James Thomson from the University of Wisconsin, USA while embryonic stem cells from the mouse were first created in 1981.
6. What is the significance of Dolly the sheep? She was the first mammal cloned from an adult (somatic) cell. This was in 1996 at the Roslin Institute in Scotland. Dolly was named after Dolly Parton as the donor somatic cell used was from a mammary gland.
7. Locate on the time line all references to Somatic Cell Nuclear Transfer (SCNT) and answer the following questions.
  - a. When did scientists first publish findings on SCNT and in which organism? 2000 in mice.
  - b. How long after Dolly the sheep were the first successful SCNT stem cells produced in humans? Never. Remains theoretical. Researchers are yet to be able to isolate embryonic stem cells from SCNT human embryos.
8. Another method or reprogramming cells is by inducing a somatic cell to become pluripotent. These cells are called induced pluripotent stem cells (iPS).
  - a. In which year and in which organism were iPS cells first created and by whom? In 2006, in mice and by Professor Shinya Yamanaka and colleagues from the University of Kyoto, Japan.
  - b. What year was news of the creation of human iPS cells published? 2007.
  - c. How many years did it take for scientists to move from non-human iPS to the creation of disease specific iPS cells in humans? Mice iPS cells were created in 2006 and the human disease iPS cells were created in 2007. That is one year between these discoveries.
9. What are MSCs? Mesenchymal stem cells
  - a. Are MSCs embryonic stem cells or tissue stem cells? Tissue stem cells isolated from the bone marrow of the umbilical cord.
  - b. Name three disorders on which are scientist's trialling their use? Crohn's disease, diabetes, cardiac disease and bone repair.
10. When did scientists first report clinical trials on human embryonic stem cells and for what purpose? There are currently two clinical trials approved to begin involving cells generated from human embryonic stem cells. The first by an American biotechnology company Advanced Cell Technology for a rare type of blindness known as Stargardt's Macular Dystrophy. The trial was approved to proceed in March 2010 but with no current timeline. Another American biotechnology company Geron, was the first to apply to the Food and Drug Administration for approval to conduct a clinical trial using neural cells made from hESCs to treat spinal cord injury. This trial was originally approved in January 2009 but was later put on clinical hold pending the assessment of new data. The trial was then given the green light in July of 2010, the company hopes to commence in late 2010. (Information up to date at time of writing in July 2010. Check the Australian Stem Cell Centre website for updates [www.stemcellcentre.edu.au](http://www.stemcellcentre.edu.au).)



# Activity 4.1.2

## Demystifying stem cell use. What are stem cells really being used for?

### Teacher directions

Before students have a chance to read the handout, fold the bottom half of the handout up over the text so that only the heading and the initial question can be seen. Ask students to read the first sentence and then answer the question. Ask them not to read any further. Once all students are finished writing, collate the answers on the board.

Next, ask students to open the sheet and start the activity.





# Handout 4.1.2

## Demystifying stem cell use. What are stem cells really being used for?

'What are stem cells currently being used for?' Before reading any more, write down your initial thoughts:

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Did you mention something about stem cells being used to cure diseases? The range of diseases for which there are proven treatments using stem cells is quite small and the only established stem cell therapies are those of the blood system involving transplants of haematopoietic stem cells (usually from bone marrow but with cord blood as an alternative) to reconstitute the blood. All other medical procedures involving stem cells are still currently considered 'experimental' or 'unproven'. Within the 'experimental' category, there are some promising clinical trials in the adult stem cell field in areas such as corneal, mesenchymal, skin and cartilage and some embryonic stem cell research is moving closer to clinical trials.

For example, researchers at the University of New South Wales have used stem cells cultured on a simple contact lens to restore sight to sufferers of blinding corneal disease, and are now progressing further into larger scale clinical trials. A video detailing the research is available here <http://www.youtube.com/watch?v=RYDSPFuWFDM>.

Would it surprise you to know that a great deal of research is also being conducted on using stem cells to find out more about diseases and how the body works? This research includes investigating genetic, molecular and biological control of tissue growth and development. Scientists are also using stem cells to *find out* more about different diseases and how they affect cells. Scientists are also using stem cells to screen drugs (toxicology testing).

### Stem cells are used for research

Research into cell differentiation and development can tell scientists a lot about how the human body works. By knowing which genes turn on and off and what affect this has on our development, they can better understand diseases like cancer and other growth abnormalities of the tissues and organs. By investigating the effects of disease on cells, scientist can also develop new strategies for treatment.

**Question 1: What affect does 'switching on and off' genes have to do with development?**

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### Cell based therapies

Treatment of disorders using stem cells has enormous potential. Tens of thousands of bone marrow and cord blood transplants are conducted worldwide every year. Bone marrow and cord blood transplants are help patients with many diseases (see table 4.1.2).

**Table 4.1.2 Diseases which bone marrow and cord blood are use to aid in treatment**

Leukaemia's and lymphomas	Bone marrow failures	Immune system disorders	Haemoglobin disorders	Metabolic disorders
<ul style="list-style-type: none"> <li>■ Acute and chronic myelogenous leukaemia</li> <li>■ Hodgkin's lymphoma</li> <li>■ Juvenile myelomonocytic leukaemia</li> </ul>	<ul style="list-style-type: none"> <li>■ Fanconi anemia</li> <li>■ Severe aplastic anemia</li> <li>■ Pure red cell aplasia</li> <li>■ Paroxysmal nocturnal hemoglobinuria</li> </ul>	<ul style="list-style-type: none"> <li>■ Severe combined immunodeficiency (SCID)</li> <li>■ Wiskott-Aldrich syndrome</li> </ul>	<ul style="list-style-type: none"> <li>■ Beta thalassemia</li> <li>■ Sickle cell disease</li> </ul>	<ul style="list-style-type: none"> <li>■ Hurler's syndrome</li> <li>■ Metachromatic leukodystrophy</li> <li>■ Adrenoleukodystrophy</li> </ul>

**Question 2** The table below shows the steps involved in a bone marrow transplant. However, the phrases are mixed up. Renumber the phrases in the correct sequential order.

Phrases	Correct order
For the second phase of treatment doctors recommend a bone marrow transplant to aid in long term remission and assist in repair of the immune system.	
Without properly formed white blood cells, the patient has no way of fighting infections or other pathogens. The abnormal white blood cells crowd out normal red and white blood cells.	
The bone marrow cells are extracted from the brother and injected into the patient.	
In this type of leukaemia, white blood cells do not develop properly. The malformed cells are called leukaemia cells.	
Bone marrow and cord blood contains haematopoietic stem cells which can make blood and immune system cells, such as red and white blood cells. This can aid in resupplying the immune system with healthy cells.	<b>6</b>
Doctors suggest the following treatment plan for this patient. First chemotherapy to destroy the leukaemia cells. This aims to kill the leukaemia cells, but unfortunately also kills healthy cells.	
The patient is diagnosed with Acute myelogenous leukaemia.	
A bone marrow donor is found. It is the patient's brother, who is a HLA match (HLA stands for human leukocyte antigen). It is a protein found on the surface of cells. If this protein is a match, the transplanted tissue is less likely to be rejected. This type of transplant is called an allogeneic transplant, as donor tissue is being used.	

Most other cell based therapies that involve stem cells are in their infancy or are in clinical trials.

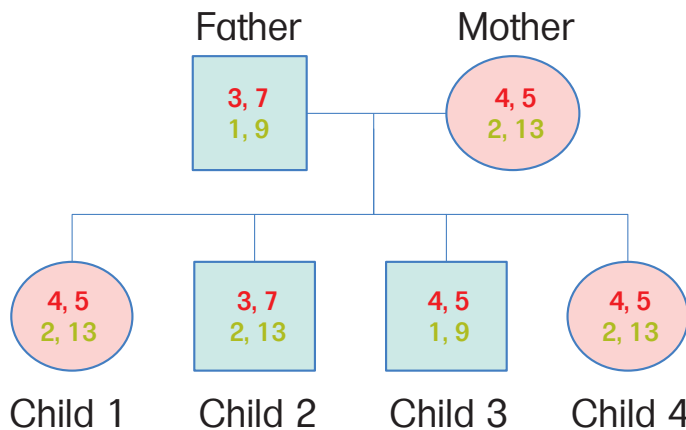
Of these cell based therapies, most success has been in transplanting stem cells into an area of the body where there is an injury. The idea is for the new stem cells to start dividing and repair the damaged tissue. This may occur because the stem cells give rise to new tissue specialised cells or they produce proteins or factors that promote repair or recovery of damaged cells at the site of injury. Irrespective of the actual mechanism, injecting stem cells from a donor (allogeneic transplant) raises the issue of tissue rejection (if HLA – human leukocyte antigen is different. See question 3). Using a patient's own cells, such as tissue cells (autologous transplant), eliminates that problem. However, finding and deriving the relevant adult stem cells can be difficult.

### Explaining HLA matching

HLA stands for human leukocyte antigen. The HLA is the human form of the major histocompatibility complex (MHC). The MHC in most vertebrates is the protein that identifies whether a cell is a 'self' cell or whether it is a pathogen.

There are HLA proteins on the surfaces of white blood cells and many other tissue cells in the body. If the immune system white blood cells detect a cell as having a different HLA match, the immune system will tag that cell for destruction. If the HLA protein is the same, then tissue rejection is reduced. The HLA mismatch is the main reason why donor organs can be rejected.

Below is a hypothetical pedigree of a family. The numbers in the boxes refer to the HLA group numbers (In this example we are only looking at the HLA-A and HLA B genes which are located very close together on chromosome 6. These HLA genes give rise to the surface proteins. Of these two genes, there are 59 different HLA-A proteins and 118 different HLA-B proteins possible in humans. The numbers refer to the particular protein that each person makes based on their HLA genes. If the numbers are the same for these genes, then the relatives can act as donor and recipients of bone marrow, cord blood or donated organs. (NB This example has been simplified for explanation purposes. In modern day organ and tissue donation more than two HLA genes are matched.)



**Question 3. Which members of the family could act as donor–recipient matches? Explain your answer.**

### New Drugs and no more animal testing:

Why are stem cells desirable for research? Embryonic stem cells grow indefinitely in the lab and are pluripotent. They can be changed into any cell type, as long as scientists know the right signals. This means scientists can have a mass of dividing cells in the lab, with which they can study normal development, disease and progression of a disease. For example, scientists have grown heart stem cells in a culture dish and the cells have started beating! For footage of beating heart cells from a Monash University researcher, visit <http://www.youtube.com/watch?v=VHHwHrx0bxg>.

So the potential scenario in the future that scientists are looking at is: instead of having to keep mice, rats and sheep in the lab, scientists can now use flasks of self renewing stem cells to test new drugs and study diseases. Using stem cells for these purposes may therefore reduce the number of animals used in scientific research but it will not eliminate the need altogether.

### Further review questions

- At the start of this activity you were asked a question about current stem cell use. Describe what you now know about the most common and approved uses of stem cells in therapy.
- Knowing that much of the research involving embryonic stem cells examines the development and pathology of diseases and not directly ‘curing people’, would your opinion on the use of ESCs change?
- ESCs are capable of self renewal and are quite prolific in the lab (many cells can be made). Why is this appealing to scientists?
- When development of hESC therapies advance to treatment of diseases in the future, describe any potential disadvantages for their use in recipient patients? What might be an alternative way of obtaining pluripotent stem cells for these patients in the future?
- Describe the benefits of using stem cells to study diseases and to test the effects of new drugs?
- Why might using more than one donor hESC type in toxicology research (testing the effects of new drugs) be advantageous?



# Handout 4.1.2

## Demystifying stem cell use. What are stem cells really being used for?

### – Teacher copy

#### Answers from text

Question 1 What affect does 'switching on and off' genes have to do with development?

Genes code for proteins. Proteins are used for a number of signalling, structural and metabolic processes. If certain genes are not switched on, these proteins products are not made and an organism will not be able to grow and function properly. If genes are not switched off, too much of a gene product is made. This can also be advantageous for normal growth and function.

Question 2

Phrases – ANSWERS	Correct order
The patient is diagnosed with Acute myelogenous leukaemia.	1
In this type of leukaemia, white blood cells do not develop properly. The malformed cells are called leukaemia cells.	2
Without properly formed white blood cells, the patient has no way of fighting infections or other pathogens. The abnormal white blood cells crowd out normal red and white blood cells.	3
Doctors suggest the following treatment plan for this patient. First chemotherapy to destroy the leukaemia cells. This aims to kill the leukaemia cells, but unfortunately also kills healthy cells.	4
For the second phase of treatment doctors recommend a bone marrow transplant to aid in long term remission and assist in repair of the immune system.	5
Bone marrow and cord blood contains haematopoietic stem cells which can make blood and immune system cells, such as red and white blood cells. This can aid in resupplying the immune system with healthy cells.	6
A bone marrow donor is found. It is the patient's brother, who is a HLA match (HLA stands for human leukocyte antigen. It is a protein found on the surface of cells. If this protein is a match, the transplanted tissue is less likely to be rejected. This type of transplant is called an allogeneic transplant, as donor tissue is being used.	7
The bone marrow cells are extracted from the brother and injected into the patient.	8

Question 3 Sisters could donate to receive bone marrow or organs from each other.

## Further review questions

4. At the start of this activity you were asked a question about current stem cell use. Describe what you now know about the most common and approved uses of stem cells in therapy.

The only proven treatments involving stem cells is for the treatment of some blood and autoimmune diseases. These treatments involve either bone marrow or cord blood. Further detail on these conditions can be found in the text.

5. Knowing that much of the research involving embryonic stem cells examines the normal development and the pathology of diseases and not directly 'curing people', would your opinion on the use of ESC's change?

Again, the answers will vary. The aim is for students to start thinking about how their possible misconception has shaped their opinion on stem cell derivation.

6. ESCs are capable of self renewal and are quite prolific in the lab (many cells can be made). Why is this appealing to scientists?

Because they only need a small number of ESCs to make a culture. Moreover some biological and molecular analyses can only be done with relatively large numbers of cells.

7. When development of hESC therapies advance to treatment of diseases in the future, describe any potential disadvantages of their use in recipient patients? What might be an alternative way of obtaining pluripotent stem cells for these patients in the future?


The MHC (or HLA) of the ESCs and the donor may not match, therefore the donor cells may be rejected. An alternative way of obtaining pluripotent stem cells might be to use iPS or SCNT stem cells. However, the development of these technologies must advance at the same rate as the ESC technologies for this hypothetical scenario to be viable. NB Both of the answers to this question are hypothetical, as the technology in both areas is still in its infancy. The main purpose of this question is for students to apply their knowledge on stem cells in a different scenario.

8. Describe the benefits of using stem cells to study diseases and to test the effects of new drugs?

Reduces the need to use other animals. Other animals have different genes to us and express different proteins, which may not react the same way to drug as humans do. So using human specific tissue, without having to harm a human is appealing. However, the issue of harming the embryo is still a hotly debated topic. Use of stem cells will not completely eliminate animal testing.

9. Why might using more than one donor hESC type in toxicology research (testing the effects of new drugs) be advantageous?

The genotype of one individual may have certain alleles that would react differently to certain drugs. Thus a single donor cell type is NOT predictive or informative for a population or different genetic/ethnic groups. For example, some bacteria are penicillin resistant, so using only one kind of genotype to test the effects of a drug is a limitation.



# Activity 4.2

## Uses of stem cells

### – media review

#### Purpose

Stem cell research and use usually features prominently in the media. This task utilises these articles to demonstrate to students the many ways in which stem cells are being used to help treat patients with a variety of illnesses and also the research that is being conducted to help patients in the future.

#### Class time

30 minutes to read and summarise the article, 10–15 minutes to present articles to the rest of the class.

#### Resources required

Copy of each article, or access to computers to view articles online.  
Electronic or hard copy of the table 'Media article review table'.

#### Student knowledge outcomes

- To further develop an appreciation for different uses and future uses of the different types of stem cells in treating diseases and disorders.

#### Student skills outcome

Reading comprehension, summarising information, critically analysing a media article, problem solving, reasoning, application of knowledge, evaluation and communicating findings to a group.

#### Prior knowledge

- What stem cells are and the types of stem cells.

#### Common misconceptions

- Stem cells are only used for treating diseases.

*Fact: Not true. The majority of work in the field of stem cells centres on research into understanding normal development, progression of diseases and disorders and toxicology screening (testing new drugs).*

#### Further Resources

- Overview of current research being done with stem cells: <http://www.stemcellcentre.edu.au/research.aspx>
- NIH website: <http://stemcells.nih.gov/info/basics/basics6.asp>

#### Teacher directions

Assign one of the suggested media articles to a student (or pair of students). The students are to read the article and then summarise the use of stem cells in that instance. Students can use the summary table to help visualise their thinking. At the completion of the exercise ask students/pairs to present their article to the rest of the class.

#### List of articles

- <http://www.news.com.au/breaking-news/stem-cells-on-contact-lens-help-to-heal-eyes/story-e6frku0-1225717120539>
- <http://www.news.com.au/old-dogs-gain-from-new-stem-cell-tricks/story-e6frfkp9-1225699503791>
- <http://www.adelaidenow.com.au/news/south-australia/funding-grant-for-gum-disease-stem-cell-research/story-e6frea83-1225754171627>
- <http://www.adelaidenow.com.au/news/south-australia/stem-cell-link-to-brain-repair/story-e6frea83-111117502823>
- <http://www.theaustralian.com.au/news/health-science/stem-cells-heal-where-surgery-fails/story-e6frg8y6-111117265753>
- <http://www.abc.net.au/science/articles/2010/02/16/2820219.htm>
- <http://news.bbc.co.uk/2/hi/health/8368976.stm>
- <http://www.news.com.au/features/breast-cancer-victims-could-grow-new-breasts/story-e6frfl49-1225796717854>



# Handout 4.2

## Uses of stem cells

### – media review

Stem cells are proving to be very versatile in the field of medical science. There are many scientists who are discovering ways of using stem cells to help sick or injured people.

Read the article that has been assigned to you and fill in the following table as a summary. Present your summary to the rest of the class.

### Media article review table

What was the main point/s of the article?


What types of stem cells are being used in this instance?

How are stem cells being used to cure the disease/disorder?  
How does the patient benefit?

Who would benefit from this new scientific advancement?

Summary of the article.





# Activity 4.3

## Stem cell research assignments

Below are two assignments that can be used as assessment tasks to monitor student understanding on stem cells and related biologic processes. The tasks also incorporate the topics of disease, homeostasis and the body's immune system and in some cases the nervous and endocrine system. The tasks also develop and assess higher order thinking skills and are designed to minimise plagiarism. Marking rubrics have been provided at the end of each assignment. The numerical grades listed are just a guide and can be adapted to suit a teacher's individual marking scheme.

Key skills for both tasks include:

- Research skills: Finding appropriate resources, disseminating information and collating information in the student's own words. Critically evaluating resources.
- Thinking skills: application of prior knowledge and acquiring new knowledge to solve a problem.

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### Activity

#### Assignment 1: 'Stem cells can cure...'

### Rational

This research assignment asks students to select a disease or injury and then research how stem cells might be able to help treat the disease or injury. Some diseases are already listed or else students can select their own (at the teacher's discretion). You can also view a list of diseases that may one day be cured by stem cells, here [http://www.cirm.ca.gov/files/images/Education\\_portal/unit\\_2/70%2B%20Diseases%20and%20Injuries.pdf](http://www.cirm.ca.gov/files/images/Education_portal/unit_2/70%2B%20Diseases%20and%20Injuries.pdf). In presenting the assignment, students assume the role of a scientist who has discovered the treatment for the disease. Students present the assignment as a report about a patient to their peers. It can be an oral, poster or written report.

#### Key knowledge

- What stem cells are, how they are derived and how they can assist the body in treating a disorder.
- Outline possible side effects to using stem cells, such as ethical considerations in obtaining stem cells, cell rejection, and limitations involving current medical technologies.
- Understand the affects of a certain disease or injury on different human body systems.

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#### Assignment 2: Stem cells help to treat mystery illness

In this assignment, students are given an incomplete fictitious newspaper article and are asked to fill in the missing information.

#### Key knowledge

- Understanding of the structure and functioning of nervous system, with particular focus on the implications of motor function with a deteriorating myelin sheath.
- The immune response in relation to an autoimmune disease.
- Self recognition in cells of the body (MHC).
- What stem cells are, how they are derived and how they can assist the body in treating a disorder.
- Outline possible side effects to using stem cells, such as ethical considerations in obtaining stem cells, cell rejection, and limitations involving current medical technologies.

# Assignment 1 ‘Stem cells can help...’

**Scenario:** You are a scientist that has discovered a way for stem cells to help cure a particular disease or injury in a patient. You are so excited about your new discovery that you want to share it with the academic world! Present your findings as an oral report, written report or as a poster.

**Step 1:** Select one of the following diseases

Leukaemia	Parkinson’s disease	Spinal cord injury	Bone fractures
Paralysis	Brain repair	Corneal problems	Alzheimer’s disease

**Step 2:** Explain how stem cells might be able to help patients with the disorder. (NB Scientists are currently trying to find ways to assist patients with these diseases. There is currently no cure for any of the disorders highlighted above, except for Leukaemia.) Follow the guidelines outlined below.

### Guidelines – your report must contain the following:

- The report should be factual and written as if you are presenting your own findings about a patient to your peers.
- You can highlight a disease that does not currently have a stem cell cure. However the science surrounding your chosen disorder must still be relevant.
- Define stem cells: what they are and how they are useful in medical situations.
- An outline of the disorder/injury. The adverse effects it has on the body, which organs it affects, life expectancy of the patient and quality of life for a patient without treatment.
- Which stem cells can be used (embryonic, adult or iPS), how the stem cells will be obtained, how they will be transferred to the patient, benefits to the patient.
- Outline possible adverse reactions or draw backs of your cure.
- Provide external links to other scientist’s research that is similar to your own.
- Self assessment:
  - As a personal learner: How well did you manage your time? Did you encounter any problems? How did you overcome them? What was difficult to accomplish? What was easy to accomplish?
  - As a content learner: What did you learn about stem cells and disease that you did not already know? How relevant and factually correct were your resources? How did you go about finding the information? How would you look for information more successfully in the future?
- Listing of references, including an annotated full bibliography and links to any news articles, journals etc.

# Assignment 1 'Stem cells can help....' marking criteria

Marking guidelines	VH 5	H 4	G/S 3	L 2	VL/ NS 1/0
Presentation and communication: Project presented as per guidelines. All required information included. Project presented with care. Use of language relevant to science, correct grammar. Use of ICT and diagrams to aid in presentation.					
Information and understanding: Accurate and relevant scientific information, project presented in students own words. Understanding of scientific content presented, clarity of information, aimed at the correct target audience.					
Application of knowledge to a new circumstance. Ability to problem solve using previous knowledge and understanding.					
Self evaluation: Thoughtful responses, depth of thinking and insightful comments.					
Gathering, analysing and evaluating data from a variety of reliable sources. Bibliography: Resources fully referenced, variety of resources used.					

Very high	High		Good		Satisfactory		Below standard (low)		Very low or Not shown	
25-24	23-20		19-15		14-10		9-5		4-0	
A+	A	B+	B	C+	C	D+	D	E+	E	NS
25-24	23-22	21-20	19-18	17-16	15-14	13-12	11-10	9-8	7-6	5-0



## Assignment 2 Stem cells help treat mystery illness

The following is a fictitious article from a newspaper called The Morning Sun Times. However the article was torn into five pieces and vital explanations at the end of each of the pieces are missing. It is your task to fill in the blanks and piece together the lost article. Rewrite the article, using your own words to fill in the blanks and make the article a whole piece again. In total the piece should be approximately 700–900 words when completed.

### Stem cells help treat mystery illness The Morning Sun Times 16th April 2010

Earlier today scientists from the Stem Cell Research Laboratory of Pluripotia (SCRLP) released a press statement detailing how they have cured the mystery illness that has been sweeping the town of Pluripotia.

The illness has been identified as a type of autoimmune disorder. ‘The body seemed to be destroying the myelin sheath that surrounds the axons in nerve cells’ said Dr Sue Woodford, Chief Scientist at the SCRLP. ‘The myelin sheath is important in humans because it .....

Immune system expert, Professor Dianne Brightspark explained that autoimmune disorders affect the immune system in a similar way. ‘The autoimmune disease modus operandi can be explained in general terms’ she said. ‘An autoimmune disorder starts when certain cells in the body fail to recognise other organs in the body as being ‘self’ organs. This is because each cell in the body has surface proteins that.....

Scientists at the SCRLP went about finding a way to treat this illness that has stricken so many in Pluripotia. Project Leader, Dr Bill Hargraves led the team which developed the treatment for this illness. ‘Once scientists had classified the illness as an autoimmune disorder, we had a good idea about how to proceed with treatment’ said Dr Hargraves. ‘Firstly scientists .....

‘Once the immune system was ‘knocked out’ so to speak, scientists could proceed with the stem cell therapy’ explained Dr Hargraves. ‘We used stem cells because they are so useful. There are three main types of stem cells, each with pros and cons associated with their derivation and use. Let me explain.....

Dr Hargraves continued ‘In regards to this particular case, scientists decided to use one of the types of stem cells that I mentioned before. These stem cells were very useful in helping treat the patients because.....

**Guidelines:** All student completed sections of the article should be the students own original work except when using direct quotes (which must be referenced properly). A full bibliography must be included at the end of the completed article.



# Assignment 2 Stem cells help treat mystery illness

## – marking criteria

Marking guidelines	Excellent 5	Good 4	Satisfactory 3	Low 2	Very low/absent 1/0
Presentation and communication	Project presented as per guidelines. All required information included. Project very well presented. Language relevant to science, correct grammar. Excellent use of ICT to aid in presentation.	Project presented as per guidelines. Most of the required information included. Project well presented. Most language relevant to science, correct grammar. Good use of ICT to aid in presentation.	Project mostly presented as per guidelines. Most/some of the required information included. Project presentation good/satisfactory. Most/some language relevant to science, some incorrect grammar. Good use of ICT to aid in presentation.	Project somewhat presented as per guidelines. Some of the required information included. Project presented satisfactorily. Some language not necessarily relevant to science, more incorrect grammar. Some use of ICT to aid in presentation.	Project guidelines not met. Little of the required information included. Project presentation below expectation. Language not always relevant to science, incorrect grammar commonplace. Little use of ICT to aid in presentation.
Information and understanding	Very accurate and relevant scientific information. Project presented in students own words. Excellent understanding of scientific content. Information is very well presented and aimed at the correct target audience.	Accurate and relevant scientific information. Project (mostly) presented in students own words. Very high understanding of scientific content. Information is well presented and aimed at the correct target audience.	Scientific information is mostly accurate and somewhat relevant. Project mostly always presented in students own words. Good understanding of scientific content. Information is presented satisfactorily and aimed at the correct target audience.	Scientific information is sometimes accurate and somewhat/not quite relevant. Project sometimes/not always presented in students own words. Satisfactory/low understanding of scientific content. Information is presented satisfactorily but not always aimed at the correct target audience.	Scientific information is not very accurate and not relevant. Project sometimes/not presented in students own words. Low understanding of scientific content. Information is not well presented and not always aimed at the correct target audience.
Application of knowledge in new situations and problem solving. Overall understanding of content.	Excellent application of knowledge and understanding to a new circumstance. Excellent problem solving skills used. Article reflects a high understanding of relevant scientific concepts.	Good application of knowledge and understanding to a new circumstance. Good problem solving skills used. Article reflects a good understanding of relevant scientific concepts.	Satisfactory application of knowledge and understanding to a new circumstance. Satisfactory problem solving skills used. Article reflects a satisfactory understanding of relevant scientific concepts.	Low/poor ability to apply knowledge and understanding to a new circumstance. Poor problem solving skills used. Article reflects a poor understanding of relevant scientific concepts.	Little/no ability to apply knowledge and understanding to a new circumstance. Poor/no ability to problem solving. Article reflects little/no understanding of relevant scientific concepts.
Evaluation of resources: Choice of quotable material.	Choice of quotable material shows an excellent ability to gather, critically analyse and evaluate a variety of resources.	Choice of quotable material shows a good ability to gather, critically analyse and evaluate a variety of resources.	Choice of quotable material shows a satisfactory ability to gather, critically analyse and evaluate a variety of resources.	Choice of quotable material shows a poorly developed ability to gather, critically analyse and evaluate a variety of resources.	Choice of quotable material or lack of relevant quotable material shows an inability to gather, critically analyse and evaluate a variety of resources.

Excellent		Good			Satisfactory			Below standard (low)			Very low or absent
20–18		17–14			13–10			9–5			4–0
A+	A	B+	B	C+	C	D+	D	E+	E	UG	NS
20–19	18	17–16	15	14	13–12	11	10	9–8	7–6	5	4–0

