APPENDIX 4

STEM CELLS, CLONING AND RELATED ISSUES

National Health and Medical Research Council, Australia

What are stem cells?

- Stem cells are 'unspecialised' cells that have the unique potential to develop into 'specialised' cell types in the body (for example blood cells, muscle cells or nerve cells). This can be either for growth and development, or for replenishment and repair.

- Stem cells occur at all stages of human development, from embryo to adult— but their versatility and numbers tend to decrease with age.

- Given the right conditions in the body or the laboratory, stem cells (unlike muscle cells, nerve cells and or blood cells) can replicate themselves many times over.

- When a stem cell replicates, the resulting cells can either remain as stem cells or can become specialised cells.

Why is stem cell research important?

Doctors and scientists believe that stem cell research has the potential to revolutionise medical treatment in two main areas:

- **Better understanding of diseases such as cancer.** By understanding how stem cells transform into the specialised cells that make us what we are, we can better understand and cure diseases such as cancer. Cancer is a major example of where this process has gone wrong.

- **Making cells and tissues to replace or regenerate tissues that are either diseased or have been destroyed.** Organ transplants can be used for this in some cases, but the demand for suitable donated organs exceeds supply. Stem cells offer the possibility of a source of replacement cells that could be used to treat diseases and conditions from Parkinson's disease to heart disease, spinal cord injury, diabetes and arthritis.

What are embryonic stem cells and adult stem cells?

Embryonic stem cells

- Embryonic stem cells, as their name suggests, are derived from human embryos. They have the potential to develop into **all** cell types in the body.

- In Australia, embryonic stem cells are derived from human embryos that are left over from assisted reproductive technology (ART) treatment programs and have been donated to research by the couple for whom they were created. They are **not** derived from eggs fertilised in a woman's body.

- As part of a couple's infertility treatment these ART embryos would have been placed in cold storage within 2–6 days of fertilisation.

Adult stem cells

- Adult stem cells (often called **somatic stem cells**) are found in many organs and tissues of the body, where their main function is to replace cells that have died in the tissue or organ where they are located.
- In certain circumstances, adult stem cells may "transdifferentiate" into othercell types.
- Adult stem cells extracted from the bone marrow of patients or compatible donors are used routinely in treating diseases such as leukaemia. (All blood cells in the body are manufactured in the bone marrow).
- Umbilical cord blood, extracted from the umbilical cord and placenta when a baby is born, is a rich source of adult stem cells. These cells may be useful for medical research or therapeutic use in the future. In the USA in particular, a whole industry has developed where people are having cord blood frozen for possible use later in life.

Embryonic and adult stem cells in medical research

- Most experts think that research involving both embryonic and adult stem cells will lead to a new understanding of, and new therapeutic treatments for, injury and disease.
- The advantages of embryonic stem cells are that they can be grown in the laboratory for long periods and be made to change into most types of tissue found in the human body.
- Some people have genuine and strongly held views against the use of embryonic stem cells in research. This is because deriving stem cells from embryos destroys the embryo.
- Adult stem cells are present in the body in low numbers, and, with the exception of bone marrow, are difficult to obtain.
- Although adult stem cells are currently difficult to grow in the laboratory and may not develop into every kind of cell, recent developments in this field are promising.

What about cloning?

- The *Prohibition of Human Cloning Act 2002* does not permit the creation of human embryo clones for any purpose (see next section on Current Guidelines and Laws in Australia).
- The scientific technique through which human embryo clones can be created is called somatic cell nuclear transfer, or SCNT. This was the technique used to create the first cloned mammal, 'Dolly' the sheep.
- SCNT involves obtaining a woman's egg cell in the same way eggs are obtained for ART treatment, then removing the genetic material (DNA) from it and replacing it with DNA from a cell of a person's body (e.g. a skin cell). With the right triggers this new cell can be turned into an embryo.
- SCNT is controversial for two reasons:

1. *The resulting embryo could, in theory, lead to cloned human beings.* If a cloned embryo is placed into a woman's uterus, and it implants and develops to birth, a new human being will be created whose nuclear DNA will be identical to the person who donated the original body cell. There is no scientific evidence that a human being has ever been cloned, and attempts to clone other primates have been unsuccessful. This possibility is referred to as '**reproductive cloning**', which many people find completely unacceptable.

2. *Stem cells could be harvested from the cloned embryo, which would destroy the embryo*. If a cloned embryo is grown in the laboratory for a few days, stem cells could be harvested from it to form a new embryonic stem cell line. This possibility is often referred to as '**therapeutic cloning**', since the embryonic stem cells could be encouraged to develop into human tissue or (possibly in the future) a complete organ for transplant. Because the stem cells from a cloned embryo have identical nuclear DNA to the person who donated the original body cell, this theoretically overcomes the 'rejection' hurdle that exists with current organ or tissue transplants or with stem cells derived from embryos left over from IVF treatment programs.

- The *Prohibition of Human Cloning Act 2002* does not distinguish between 'reproductive' and 'therapeutic' cloning.

- It has also been suggested that so-called 'therapeutic cloning' could be achieved by transferring human DNA into animal eggs (such as rabbit eggs), as a way of reducing the demand for human egg donations.

- The technique would be illegal in Australia under the *Prohibition of Human Cloning Act 2002* because it could result in the creation of a hybrid embryo.

Current guidelines and laws in Australia

Use of cell lines in research

- The use of human or animal cell lines in health and medical research is covered by guidelines and other statements issued by the National Health and Medical Research Council (NHMRC).

- Researchers should abide by the provisions of the *National Statement on Ethical Conduct in Human Research* (1999, under review).
[http://www.nhmrc.gov.au/publications/synopses/e35syn.htm]

- The NHMRC has also prepared a supplement to the *National Statement*, on preparation and review of research protocols relating to the use of embryonic and non-embryonic human stem cells. [http://www.nhmrc.gov.au/ethics/human/issues/stemcell.htm]

Use of human embryos to derive embryonic stem cell lines

Research Involving Human Embryos Act

- The use of human embryos to derive human embryonic stem cell lines for research is governed by the *Research Involving Human Embryos Act 2002*. The Act states that only embryos that are left over from ART (Assisted Reproductive Technology) treatments can be used can be used in this kind of research. Embryos cannot be created purely for the purposes of research.

[http://www.comlaw.gov.au/ComLaw/Legislation/ActCompilation1.nsf/0/41F0A356529C8567CA25719C0031E76D/$file/Research+Involving+Human+Embryos+Act+2002_WD02.pdf]

Assisted Reproductive Technology (ART) guidelines

- ART includes techniques such as IVF (in-vitro fertilisation, or fertilisation in an artificial environment such as a test tube).
- ART itself is subject to ethical guidelines on ART, and supplementary statements on the use of human tissue in research, issued by the NHMRC. [http://www.nhmrc.gov.au/ethics/human/issues/art.htm]
- The ethical guidelines on ART outline the comprehensive consent process for couples who wish to declare embryos as excess to their requirements, and to allow the embryos to be used for research purposes.

Embryo Research Licensing

- The use of excess ART embryos in research, including as a source of embryonic stem cell lines, can only be undertaken if authorised by a licence issued by the **NHMRC Embryo Research Licensing Committee**. More information on the Committee, its functions and current membership [http://www.nhmrc.gov.au/about/committees/lc/index.htm]
- More information on the issuing of licences to use excess assisted reproductive technology embryos is available on our licensing FAQs page. [http://www.nhmrc.gov.au/embryos/information/faqs.htm]

Human cloning

- Human cloning, in any form, is banned in Australia under the *Prohibition of Human Cloning Act 2002*. [http://www.comlaw.gov.au/ComLaw/Legislation/ActCompilation1.nsf/0/4374F568FE759928CA2570450002C19A/$file/ProhibHumanCloning2002_WD0 2.pdf]

More information and advice on the regulatory framework

- More information and advice on the regulatory framework relating to human cloning and research involving human embryos, and Commonwealth and State and Territory legislation, is available on the NHMRC's Policy and Guidance web page. [http://www.nhmrc.gov.au/embryos/information/index.htm]

The Lockhart Review

- The Legislation Review Committee established to review the *Prohibition of Human Cloning Act 2002* and the *Research Involving Human Embryos Act 2002*, reported to Parliament and the Council of Australian Governments on 19 December 2005. The review is known as the Lockhart Review, after its Chair, the late Justice John Lockhart.
- The Review Committee's reports cover areas involving difficult ethical issues, about which people have divergent and deeply held views.

- The Committee endorsed the strong regulatory framework which regulates research involving excess assisted reproductive technology embryos, and prohibits human cloning.

- The Review Committee made 54 recommendations, many of which are interlinked. These recommendations are explained briefly below (the groupings are not related to any perceived merits or otherwise of the recommendations):

  – **(a) Maintaining the existing legislative framework, including the ban on reproductive cloning**

    These recommendations provided strong support for the current regulatory framework, including the use of excess assisted reproductive technology (ART) embryos in research.

    Recommendations 1 to 14; 31; 33, 34; 37; 38; 40; 43, 44; 46.

  – **(b) Development of advice, guidance and infrastructure within the existing regulatory framework:**

    These recommendations are of an administrative nature and are directed at the NHMRC, government and other parties. For example, recommendation 18 recommends the NHMRC develop a pro-forma licence application. Other recommendations relate to advice and criteria for licensing the use of fresh ART embryos that are unsuitable for implantation into a woman. There are also recommendations that a national Australian stem cell bank and a national register of donated excess ART embryos be established.

    Recommendations 18, 20, 21, 22, 29, 30, 32, 36, 45, 46, 47, 48, 49, 54.

  – **(c) Allowing 'therapeutic cloning' and other currently prohibited techniques:**

    Recommends that so-called 'therapeutic cloning' be permitted using a technique known as somatic cell nuclear transfer (SCNT).

    Recommends allowing creation of other types of embryos whose creation is currently prohibited by the *Prohibition of Human Cloning Act 2002*, including through SCNT using animal eggs (to reduce the demand for human eggs), and cytoplasmic transfer (creation of human embryos using the genetic material from more than two people).

    Recommends extending the role of the NHMRC Embryo Research Licensing Committee to include licensing these additional activities.

    Recommendations 23, 24, 25, 26, 27, 35, 42.

  – **(d) Amending the definition of human embryo:**

    Recommendation that the definition of human embryo be amended. The proposed definition starts at the point of the first cell division after ertilisation of a human egg by a human sperm.

    Recommendation 28.

  – **(e) Allowing research on fertilisation up to the point of the first cell division:**

    These recommendations are linked to the recommended change to the definition of a human embryo and are aimed at facilitating research into fertilisation, testing

of eggs for maturity, and cytoplasmic transfer up to, but not beyond, the point of the first cell division.

Recommendations 15, 16, 17, 19.

- **(f) Provide additional powers to NHMRC inspectors:**

  Recommendation that inspectors be given powers of entry, inspection and enforcement in relation to non-licensed facilities.

  Recommendation 39.

- **(g) Removing restrictions on the import and export of human embryos:**

  Recommendation for streamlining provisions relating to a patient's reproductive material (including ART embryos), for that person's ongoing ART treatment.

  Recommendation 41.

- **(h) NHMRC Embryo Research Licensing Committee rulings:**

  Recommendation that the legislation be amended to give the Licensing Committee the power to make binding rulings in relation to interpretation of the legislation, in order to provide greater regulatory flexibility in this fast-moving field.

  Recommendations 50 to 52.

- **(i) Provide for further review of national legislation:**

  In view of the fast-moving developments in the field the two Acts should be subject to a further review either six years after Royal Assent to the current Acts or three years after Royal Assent to any amended legislation.

  Recommendation 53

- The Committee's reports are available at www.lockhartreview.com.au.
- The NHMRC submission to the review is available at http://www.lockhartreview.com.au/_pdf/701-800/LRC790.pdf
- Australian Governments are currently considering the Review Committee's reports.

Facts and figures on embryos, licences and funding

Number of embryos and licences

- There were 104,830 embryos in frozen storage in 2003. Almost all of these were embryos intended to be used to achieve a pregnancy.
- Very few ART embryos in storage have been declared to be excess to ART requirements.
- At 31 March 2006:
  - 170 excess ART embryos had been used in licensed research in Australia
  - the NHMRC Embryo Research Licensing Committee had issued 9 licences authorising the use of up to 1,735 excess ART embryos

  - 4 of the 9 licences authorised the use of up to 550 excess ART embryos for the derivation of human embryonic stem cells.
  - under the 4 licences, 122 excess ART embryos had been used.
- More information on embryo and licence numbers is available at http://www.nhmrc.gov.au/embryos/information/faqs.htm

Australian Government funding for stem cell research

NHMRC funding

- Around $40 million of NHMRC funding in 2006 is committed to research that involves the use of animal or human stem cells. This is approximately 9% of NHMRC research expenditure in 2006 ($435 million).
- Approximately $1.8 million in research funding involves use of human embryonic stem cells.
- A complete breakdown of NHMRC funding in 2005 and 2006 for research involving stem cells is available at http://www.nhmrc.gov.au/publications/_files/stemcell_funding.pdf

Other Australian Government funding

Australian Stem Cell Centre, Melbourne

- In 2002 the Australian Government provided the Australian Stem Cell Centre in Melbourne with a competitively awarded grant of $43.55 million through the Government's *Backing Australia□s Ability*, Biotechnology Centre of Excellence Program (*Backing Australia□s Ability* is coordinated across five principal portfolio Departments).
- In May 2004, the Prime Minister announced a further $55 million grant under *Backing Australia□s Ability II*, to support the Australian Stem Cell Centre's activities from 2006 to 2011.
- The Australian Stem Cell Centre is a key driver and catalyst in developing world-class capability in biotechnology research, and its application for the economic and social benefit of Australia.
- More information on the Australian Stem Cell Centre is available at http://www.stemcellcentre.edu.au/ascc_home.html

Adult Stem Cell Research Centre, Brisbane

- On 2 May 2006 the Government announced that it had decided to provide $22 million over four years to fund an Adult Stem Cell Research Centre at Griffith University in Queensland.
- This Centre is funded through the Commonwealth Department of Health and Ageing, and will complement the work of the Australian Stem Cell Centre.
- More information on the Adult Stem Cell Centre is available at http://www.griffith.edu.au//centre/eskitis/home.html

International website links

The following websites provide useful and authoritative information on stem cells, cloning and related issues

- National Institutes of Health (USA) Stem Cell Information website http://stemcells.nih.gov
- BBC World Service Education Home Page (Science and Technology) http://news.bbc.co.uk/1/hi/sci/tech/859672.stm
- American Federation for Aging Research Cloning and Information Centre http://websites.afar.org/site/PageServer?pagename=IA_b_cloning_home

Source: http://www.nhmrc.gov.au/publications/_files/stemcells.pdf [accessed 30.10.06]