Overview on the Current State of the
Development of New Human Embryonic Stem Cell Lines

Introduction

The following overview provides a high-level summary of the current status of activity to date related to the development of human embryonic stem cell (hESC) lines. It is intended to provide some background for our discussion and is not intended to be comprehensive or exhaustive.

I. Current Status of hESC Lines

1) Federal Policy (1)

- On August 9th, 2001, President Bush announced that federal funds may be awarded for research using human embryonic stem cells only if the following criteria are met:
  - The derivation process was initiated prior to 9:00 P.M. EDT on August 9, 2001.
  - The stem cells must have been derived from an embryo that was created for reproductive purposes and was no longer needed.
  - Informed consent must have been obtained for the donation of the embryo and that donation must not have involved financial inducements.

2) hESC Lines Approved for Federal Funding

- What is the total number of viable lines currently available?
  - The 2001 policy limited federal funding to 64 hESC lines in existence at that time (2).
  - Retraction by donors and failure in culture reduced the number of lines eligible for federal funding to 22; a recent hold on distribution of one cell line reduced the number to 21 (3).
  - None of the lines eligible for federal funding are disease-specific (4).

- Are the hESC lines approved for federal funding suitable for transplantation into humans?
  - The NIH lines were grown using animal products such as mouse feeder layers.
    - This may limit their clinical applications because the FDA considers these human cell lines to be xeno products and they will have to fulfill all the requirements for xenotransplantation before they may be used in humans.
    - They may also be less commercially attractive.

- Are the hESC lines approved for federal funding suitable and available for research?
  - Yes, but opinions differ regarding the number of suitable and available lines.
    - Anecdotally, we have been told that all 22 of hESC lines eligible for federal funding discussed above have been shipped to researchers at some point, but 11 have been more heavily shipped.

- Douglas Melton of Harvard University was quoted in the *New York Times* as saying "…President Bush said that he was going to permit federal funding for scientists to work with some 60 pre-existing stem cell lines and it turned out that there were probably only about 10 usable lines. Maybe a few more." (5)
- Anecdotally, we are told that only 4 or 5 of the federally funded lines are suitable for research and readily available.

3) hESC Lines NOT Approved for Federal Funding

- What is the total number of viable lines currently available?

Table 1: Human Embryonic Stem Cell Lines Derived From August 2001 - June 2005

Country	Total Lines	Derived from IVF Embryos	Derived from PGD Embryos	Published Lines	Non-Published Lines
China	2	2[a]	0	2	0
Czech Republic	7	7[b]	0	0	7
Finland	4	4[c]	0	0	4
Iran	1	1[d]	0	1	0
Israel	3	3[e,f]	0	1	2
Russia	3	3[g]	0	0	3
Singapore	1	1[h]	0	1	0
Spain	2	2[i]	0	2	0
Sweden	15	15[j,k,l]	0	8	7
Turkey	7	7[m]	0	7	0
United Kingdom	2	1[o]	1[n]	2	0
United States (Total)	54	36	18	46	8
BresaGen	*1*	*1*[p]	*0*	*1*	*0*
Harvard	*17*	*17*[q]	*0*	*17*	*0*
Reproductive Genetics Inst	*26*	*8*[s]	*18*[r]	*26*	*0*
UCSF	*10*	*10*[t,u]	*0*	*2*	*8*
Total	**101**	**82**	**19**	**70**	**31**

Source: International Society for Stem Cell Research (http://www.isscr.org/science/sclines.htm). Data as of June 17, 2005.
Note: Source data listed 19 lines derived in Korea. Due to recent developments, lines from Korea were not included in the table.
Since Jun 17, 2005, the scientific community has indicated the creation of additional lines, but publications surrounding those cell lines are not readily available.
See Appendix A for references cited above

- Are available hESC lines NOT available for federal funding suitable for transplantation into humans?
  - All current stem cell therapies currently use non-embryonic stem cells.
  - WiCell (University of Wisconsin) produced two new hESC lines in feeder-independent culture conditions with a defined medium. However, both lines developed chromosomal abnormalities after 4 and 7 months in culture, respectively (6).

- WiCell also claims to have cultured 4 existing stem cell lines under defined culture conditions for extended periods without developing chromosomal abnormalities (6).
- Geron Corporation holds a patent on technology that eliminates feeder cells from the culture process. This eliminates the risk of introduction of infectious agents from the feeder cells into a therapeutic cell population (7).

➢ Are these hESC lines NOT approved for federal funding suitable (for example, free of contamination by viruses) and available (that is, readily obtainable by the scientific community) for research?
- While most of the lines discussed above seem to be suitable for research, the exact number of such lines is difficult to estimate.
- In addition, as was the case with the NIH cell lines, this number is in constant flux, as the suitability of a given line may change with time due to contamination (for example, by viruses), the accumulation of genetic mutations, etc.
- Finally, even lines classified as "available" may be difficult to obtain.

4) Worldwide Activities in hESC Research (Note: This review is not meant to be comprehensive or exhaustive)

➢ **Australia**
- Legal Restrictions on hESC Use (8)
  - The Research Involving Human Embryos Act (2002) and the Prohibition of Human Cloning Act (2002) prohibit human cloning and regulate uses of excess human embryos.
  - The future of stem cell research in Australia is currently being reviewed by an independent panel as the legislation is up for renewal.
    - It is expected that when the review is completed it will call for therapeutic cloning to be allowed due to fears of losing Australia's best researchers to UK, Singapore, and South Korea.
- Funding (8)
  - Funding for Australian stem cell is conducted by the Australian Stem Cell Centre (ASCC). The Australian government and the State government provide the majority of funding for the ASCC.
  - In 2002, ASCC was awarded AUD $43.55 million (roughly US $33M) under the Government's Backing Australia's Ability, Biotechnology Centre of Excellence Programme.
    - The State Government of Victoria's Science, Technology and Innovation programme awarded the ASCC with an additional AUD $10 million in 2002 (roughly US $7.6M).
  - In 2004 the ASCC was awarded AUD $55 million (roughly US $41.7M) from the Government's Backing Australia's Ability II in order to fund research activities from 2006-2011.

        - The Department of Education, Science, and Training provided AUD $5.5 million (roughly US $4.2M) to ASCC to complement this funding.
        - The State Government of Victoria's Science, Technology and Innovation programmed awarded the ASCC an additional $1.375 million (roughly US $1M).
    - Focus (8)
        - Australian stem cell research has a therapeutic focus mainly on hematology and cardiac regeneration.
    - Research Activity
        - In 2000, scientists from the Monash Institute of Reproduction and Development first reported the development of nerve stem cells from embryonic stem cells (8).
        - In 2005, Australian researchers developed three clones of cells from existing human embryonic stem cells (9).

- **Canada**
    - Legal Restrictions on hESC Use (10)
        - Research to derive and study hESC lines (or other cell lines of a pluripotent nature from human embryos) is permitted provided that:
            - The embryos used were originally created for reproductive purposes and are no longer required.
            - There was free and informed consent from the persons for whom the embryos were originally created.
            - Neither the ova nor the sperm used to create the embryos, nor the embryos themselves, were obtained through commercial transactions.
    - Funding
        - In 2004/5, stem cell research in Canada was supported by the Canadian Institutes of Health Research (CIHR) in the amount of C$13 million, or roughly US $11.7M (11).
        - Established in 2001, the Canadian Stem Cell Network (CSCN) has a budget of C$5.3 million / year annually, or roughly US $4.8M, with partnerships generating an equivalent amount of funding (12).
        - The CIHR will establish an electronic national registry of hESC lines generated in Canada. Participation will be a prerequisite for obtaining CIHR funding for human pluripotent stem cell research (10).
    - Focus
        - Areas of focus include: diabetes, neural research (e.g., Parkinson's disease, multiple sclerosis, and stroke), blood, cancer, stem cell genomics, cardiac, muscle, stem cell bioengineering, and ethics (11).
    - Research Activity (13)
        - In partnership with industries, non-government organizations and government organizations, the CSCN funds research projects in four strategic areas.

- Stem Cell Applications and Cellular Therapy - Research projects with a specific disease focus aimed at developing novel stem cell related approaches to tissue repair and regeneration.
- Stem Cell Therapeutics and Drug Discovery - Research projects aimed at developing novel stem cell related therapeutics including the development of small drugs and biologics.
- Tools, Reagents and Diagnostics - Research projects aimed at generating novel tools, reagents and diagnostics for stem cell research and therapeutic applications.
- Stem Cells and Public Policy - Research projects addressing public policy questions relevant to the Network's three Strategic Programs or other issues highly relevant to the mandate of the Network.

➢ **China**

- Legal Restrictions on hESC Use (14)
  - The China's Ministry of Science and Technology (MoST) guidelines
    - Prohibit reproductive cloning but permit therapeutic cloning;
    - Permit experimentation only on embryos up to 14 days old;
    - All gametes and tissues must be voluntarily donated in accordance with the principle of informed consent;
    - Prohibit the implantation of human embryos used in research; and
    - Prohibit buying or selling human eggs, sperm, embryos, and fetal tissue.
- Funding
  - MoST's goal for 2001 - 2005 was to invest RMB 150 million, or roughly US $18.7 M, in stem cell research. From 2006 to 2010, the Ministry is expected to spend between RMB 500 million and 2 billion, or between roughly US $62.3M and US $249M (15).
- Focus
  - Scientists and clinicians are eager to pursue clinical trials of cell-based therapies with a focus on brain injury, corneal disease, and neurodegenerative illness (15).
- Research Activity
  - We have heard anecdotally that China is interested in "covering the waterfront" in terms of developing hESC lines representing a broad range of human leukocyte antigen (HLA) types.
  - In the area of Somatic Cell Nuclear Transfer (SCNT), Chinese scientists have published one of the first papers reporting an attempt to reprogram human nuclei by transfer into rabbit oocytes.

➢ **India**

- Legal Restrictions on hESC Use (16)
  - According to the draft policy prepared by the Indian Council for Medical Research (ICMR) and Department of Biotechnology (DBT):

        - For hESC research, embryos should not be generated for the sole purpose of obtaining stem cells. Only surplus, spare, or supernumerary embryos can be used after obtaining informed consent of both spouses.
        - Such collection of embryos should be done only from registered Assisted Reproductive Technique (ART) clinics.
- Focus
    - India plans to set up a "stem cell priority fund" to support research to find treatment for diabetes and heart and nerve diseases (17).
- Funding (16)
    - In 2004 and 2005, about 1 million pounds (or roughly US $1.9M) was spent on stem cell research, with DBT being the key funding agency.
    - The main goals of the DBT strategy include:
        - Promoting research for therapeutic applications using adult and embryonic stem cells.
        - Focusing on basic research and study factors that generate stem cells and how stem cells can be stopped from proliferation.
        - Studying the biology of stem cells.
    - The DBT has also invited project proposals in areas such as:
        - The study of gene and regulation and the plasticity of stem cells.
        - Development of city clusters for stem cell research involving basic researchers and clinicians.
        - The use of embryonic stem cells for drug testing.
        - Establishment of a stem cell bank.
- Research Activity
    - Two Indian centers (the National Center for Biological Sciences / Tata Institute of Fundamental Research, which derived 3 lines and Reliance Life Sciences, which derived 7 lines) have generated some of the stem cell lines that fulfill the requirements for US federal funding (18). Although these lines are not available, this indicates that scientists in India have the ability to gereate stem cell lines.

➢ **Israel**

- Legal Restrictions on hESC Use (19)
    - Israeli law prohibits:
        - The creation of a human embryo by transferring a somatic cell nucleus into an enucleated ovum / fertilized ovum.
        - The insertion of a cloned embryo into the uterus of a woman or another womb or body.
        - The use of reproductive cells that have undergone an intentional genetic modification in order to cause the creation of a person.
- Funding (20)
    - As of November 2005, there was no dedicated funding policy for stem cell research.

- Established in 2003, the Ministry of Industry and Trade Cell Therapy Consortium provides the largest sum of money for stem cell research.
- The Consortium was created to develop enabling technologies for medical applications of stem cells and other cell-based therapies.
- The Consortium has a budget of about $15-20M over 3 years with 66% funding by the government, and 34% by the industrial members.

- Focus (20)
  - Areas of research include blood, bone, liver, pancreatic, heart, and nerve cells.
- Research Activity (20)
  - Strengths in both embryonic stem cells and in adult stem cell research.
  - Israeli researchers were key players in the isolation of stem cells from human embryos in 1998 (Itskovitz-Eldor Technion, 2000 Reubinoff, the Hebrew University).
  - Together with US researchers, Israeli researchers published detailed descriptions of the differentiation of human embryonic stem cells in culture (2000, Benvenisty, Hebrew University).
  - Israeli researcher have also reported on the genetic modification of stem cells (2001, Reubinoff, the Hebrew University).

➢ **Korea**

- Legal Restrictions on hESC Use (21)
  - The Life Ethics Law (2004) prohibits reproductive cloning.
  - Nuclear transfer *and* subsequent implantation of cloned human blastocysts is not permitted.
  - The Government will approve limited research on SCNT based on the guidelines drawn up by the National Ethics Committee.
- Funding (21)
  - The Korean government has placed a high priority on stem cell research and animal cloning.
  - The Ministries of Science and Technology (MOST) and of Health and Welfare (MOHW) are the major funders of stem cell research.
  - Established in 2002, the Stem Cell Research Center's financial support originally projected to total $149.4 million by 2012.
    - Government subsidies were originally projected to account for $121.9 million of this total with the remainder coming from the private sector.
  - In 2005, total government funding for stem cell research was $17.7 M.
- Research Activity
  - In May 2005, Woo Suk Hwang and his colleagues at Seoul National University (SNU) reported making ESC from cloned human embryos. Earlier this year, however, those claims were discovered to be false (22).
  - The World Stem Cell Hub was set up at SNU Hospital with a goal of facilitating international cooperation in stem cell research, under Dr. Hwang's stewardship. South Korea has since built a gene therapy clinic at that site with

a decision as to whether or not to resume experiments with the ESCs to be made after seeing development of embryonic stem cell technologies applicable to clinical tests (23)

- Three Korean centers (the Cell and Gene Therapy Research Institute at Pochon Cha University; Maria Biotech Co., Ltd. - Maria Infertility Hospital Medical Institute; and MizMedi Hospital - Seoul National University) have generated cells on the NIH's approved for funding list (18) however only one such line was made available and distribution of that line was recently put on hold (3).

- **Singapore**
  - Legal Restrictions on hESC Use (24)
    - On 2 September 2004, the Singapore Parliament passed the Human Cloning and Other Prohibited Practices Act which prohibits reproductive cloning, and the import and export of cloned embryos, eggs, or sperm.
      - It also forbids the culture of human embryos outside the body of a woman for more than 14 days.
    - The legislation allows research on human embryos, including those created by therapeutic cloning, provided the embryo is grown for no more than 14 days.
    - The derivation of human embryonic stem cells is permitted.
  - Funding
    - Expenditures on stem cell research in Singapore is estimated at S$40-45M a year (US $25M), with approximately S$15m (US $9M) a year in the public sector and S$25-30m (US $15M) per year in the private sector (24).
    - The Biomedical Research Council (BMRC) and the US Juvenile Diabetes Research Foundation International (JDRF) jointly established a S$5.2m (US $3.2M) funding programme to support stem cell research in Singapore (25).
    - The government established a $600 million fund to invest in startups engaged in research on stem cells and other cutting-edge life-sciences projects (26).
  - Research Activity
    - Scientists in Singapore have successfully grown human embryonic stem cells in a completely animal-free culture (as have researchers at WiCell, as mentioned above).
    - Singapore is home to ES Cell International Pte Ltd (ESI), which was incorporated with seed capital provided by Life Science Investments Pte Ltd, a subsidiary of the Singapore EDB, and ES Cell Australia Ltd (ESCA), an Australian investment consortium (27).
      - ESI is using the committed funds to develop hESC technology and resulting intellectual property created by the Monash Institute of Reproduction and Development, Australia; The National University of Singapore; Hadassah Medical Organization, Israel; and the Hubrecht Laboratory, The Netherlands (27).
      - ESI makes six of the stem cell lines approved for funding by the US federal government available (18).

- Singapore has also been actively recruiting some of the best stem cell scientists in the world to implement its vision, including:
  - Alan Colman (cloned Dolly the sheep in 1997)
  - Sydney Brenner (Nobel laureate, 2002)
  - Ed Holmes

- **Sweden**
  - Legal Restrictions on hESC Use (28)
    - Research on fertilized eggs has been permitted since 1991.
      - Research is only permitted in the first 14 days after fertilization, after which the fertilized egg must be destroyed.
      - A fertilized egg which has been subject to research may not be implanted in a woman's body, nor may the purpose of the research be to create inheritable genetic changes.
    - A law came into effect on April 1, 2005 specifically allowing research on fertilized eggs for purposes other than in vitro fertilization (IVF) treatment, on the condition that such has undergone an ethical review.
      - This Act also specifically allows therapeutic cloning (somatic cell nuclear transfer) for research purposes, under the same conditions / limitations as research on fertilized eggs.
      - The Act also allows the donation of unfertilized eggs for research purposes again, if donor consent is obtained.
    - Sweden allows the donor to withdraw consent after the lines is created
  - Funding (28)
    - The main funding sources for stem cell research in Sweden are the Swedish Research Council, the Foundation for Strategic Research, domestic private foundations, and international organizations.
    - Funds allocated by the Swedish Research Council to researchers for projects involving stem cell research (not including the Stem Cell Research Programme, see below) are:
      - 2003 - 13.43M Kroner (roughly US $1.8M)
      - 2004 - 15M Kroner (roughly US $2.1M)
      - 2005 - 16.35M Kroner (roughly US $2.2M)
  - Focus (28)
    - Disease focus areas for research include Parkinson's disease, multiple sclerosis, Alzheimers disease, and diabetes.
    - A Stem Cell Research Programme has announced funding for projects and networks investigating:
      - Determination of culture conditions to induce the proliferation and differentiation of stem cells into various precursor cell types
      - Study of the regulation of cell differentiation and development that have implications for human stem cells or beta cell development

        - Identification of the genes expressed, and the temporal order of gene expression, during development of various differentiated cell types
        - Study of mechanisms to protect transplanted or newly-formed tissues from immune attack
        - Study of the ethical and legal aspects of human embryonic stem cell research
    - Research Activity
        - Cellartis AB derived 3 of the lines approved for NIH funding; one of these was withdrawn by donor and the remaining two lines are both available for shipping (28).

- **United Kingdom**
    - Legal Restrictions on hESC Use
        - Regulation of stem cell and embryo research is flexible, transparent, and clear.
        - The Human Fertilisation and Embryology Authority (HFEA) is a non-departmental Government body that regulates and inspects all UK clinics providing IVF, donor insemination or the storage of eggs, sperm, or embryos (29). HFEA has produced some of the clearest and most transparent regulations for government oversight and licensing of embryos and HESC research; by licensing it allows PGD and SCNT research.
        - The law prohibits (30):
            - Keeping or using an embryo after the appearance of the primitive streak (or after 14 days, whichever is earlier).
            - Replacing a nucleus of a cell of an embryo with a nucleus from the cell of another person, another embryo, or a subsequent development of an embryo.
    - Funding
        - The UK Stem Cell Initiative (UKSCI) was established in March 2005 and charged with developing a ten-year vision and costed strategy for UK stem cell research, for implementation between 2006 and 2015.
            - Cost estimates for the UKSCI's program of recommendations over that period next ten years range between £41M and £104M per year, or roughly US $76M and Us $193M(31).
        - The UK Stem Cell Foundation (UKSCF) was established in 2005 to support the transfer of promising stem cell techniques from the bench to the bedside. The UKSCF plans to generate a £100m funding endowment to directly fund stem cell research projects with indicated potential for direct clinical benefit to patients over 2-5 years (32).
    - Research Activity (33)
        - The British Government initiated the funding for the International Stem Cell Forum, which has two activities underway:
            - The characterization and comparison of hESC lines.
            - Creation of a UK Stem Cell Bank.

- The UK Stem Cell Bank has been established at the National Institute for Biological Standards and Control (NIBSC) in Hertfordshire.
    - The UK Stem Cell Bank will provide a repository for human stem cell lines of all types, and will be developed to supply well characterized cell lines under appropriate and accredited quality systems both for basic research and for the development of clinical applications.

II. Future State

1) Where will this field be in one year?

- A number of institutions around the world are working on the development of new stem cell lines and this activity is likely to continue to grow.

2) Opinions from interviewees to date about the creation of new cell lines

- The six interviewees to date who have specifically discussed issues related to the development of new stem cell lines shared a variety of opinions regarding what the CIRM should emphasize with regard to the development of new hESC lines:
    - Creating cell lines within the context of specific scientific projects.
    - Investigating alternatives to the use of left-over embryos derived via IVF techniques for the development of stem cell lines, such as Somatic Cell Nuclear Transfer (SCNT) and Pre-Implantation Genetic Diagnosis (PGD). [Note: There are 10 clinics in California offering PGD services (34).]
    - Creating disease-specific cell lines.
    - Addressing a lack of standardization in terms of research protocols for deriving cell lines, culturing the cells, etc.
    - Conducting a workshop to bring scientists together to discuss stem cell derivation techniques and / or offering a related course on those techniques.
    - Addressing the issue of scalability and distribution, that is, producing adequate quantities of cells from different lines for research purposes and getting them to researchers.
    - Addressing the need for cell lines derived using Good Manufacturing Procedures (GMP) and the requisite cell line stability, characterization, and other conditions that that make this possible.

III. Discussion of Technologies for Possible Funding

A number of techniques have been used or proposed for the development of new stem cell lines and may form the basis for CIRM funding initiatives. These approaches are described below:

1) Derivation of hESC lines using blastocysts derived via in vitro fertilization (IVF)

- This approach is relatively well-established and straightforward.
- It is being used in many labs around the world and requires modest resources.

- It uses blastyocysts derived from embryos discarded by IVF clinics, of which there are roughly 20 in California

2) Derivation of hESC lines via Pre-Implantation Genetic Diagnosis (PGD)

- This provides an opportunity to obtain cell lines with a limited range of disease mutations.
- This technique is presumably established, although very little has been published in peer reviewed journals.
- There are a limited number of programs using this technique.
- Though we have one anecdotal report of a lab obtaining and using lines derived by another lab, such lines have not been widely distributed or widely used.

3) Derivation using somatic cell nuclear transfer (SCNT)

- This technique, which involves the fusion of a somatic cell with an oocyte, is well established in many animals but not established in humans.
- It offers access to the broadest range of genotypes.
- In addition to proving the feasibility of the approach, it will also be necessary to establish new procedures to obtain oocytes.
- This approach has great potential in terms of its applications to disease research including understanding and defining disease pathways, identifying new targets, enabling drug discovery, and de-risking toxicology studies.

4) New technologies, such as:

- Nuclear reprogramming
- Homologous recombination

Note: These techniques are still in the experimental stages.

Appendix A - References for Table 1

[a]http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=pubmed&dopt=Abstract&list_uids=15949219&query_hl=2

[b]http://www.isscr.org/science/documents/ReportDvorak.pdf

[c]http://www.isscr.org/science/Finnish_SC_Lines.pdf

[d]http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&dopt=Abstract&db=PubMed&list_uids=15270778

[e]http://content.nejm.org/cgi/content/abstract/NEJMsr040330

[f]ISSCR 2004, abstract #79

[g]ISSCR 2004, abstract #141

[h]http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=pubmed&dopt=Abstract&list_uids=12161760

[i]http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=pubmed&dopt=Abstract&list_uids=12161760

[j]http://stemcells.alphamedpress.org/cgi/content/abstract/22/3/367?etoc

[k]http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=pubmed&dopt=Abstract&list_uids=12832363

[l]http://www.isscr.org/science/documents/Summary_table_ISSCR_uppdate_June_28_2004.pdf

[m]http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=pubmed&dopt=Abstract&list_uids=12832363

[n]http://www.ingentaconnect.com/content/repro/rebi/2005/00000010/00000003/art00017

[o]http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&dopt=Abstract&db=PubMed&list_uids=15342943

[p]1 subline from BG01, available at ATCC (# SCRC-2002), karyotype: XXY, +12, +17

[q]http://content.nejm.org/cgi/content/abstract/NEJMsr040330

[r]http://www.rbmonline.com/4DCGI/Article/Detail?38%091%09=%201590%09

[s]http://www.rbmonline.com/4DCGI/Article/Detail?38%091%09=%201558%09

[t]http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=pubmed&dopt=Abstract&list_uids=15866593

[u]ISSCR 2004, abstract #113

Appendix B - Other References

(1) http://stemcells.nih.gov/policy/NIHFedPolicy.asp
(2) http://stemcells.nih.gov/policy/statements/082701list.asp
(3) http://stemcells.nih.gov/research/registry/eligibilityCriteria.asp
(4) http://www.jdrf.org/files/About_JDRF/wp804.pdf
(5)http://www.nytimes.com/2006/01/24/science/24conv.html?ex=1148616000&en=0d02e8bc9ce2a18d&ei=5070)
(6) *Nature Biotechnology* 24:185, 2006; http://www.news.wisc.edu/11985.html
(7) http://www.geron.com/pressview.asp?id=678
(8) http://www.advisorybodies.doh.gov.uk/uksci/global/australia.htm
(9) http://www.unsw.edu.au/news/pad/articles/2005/apr/Stem_cells.html
(10) http://www.cihr-irsc.gc.ca/e/28216.html
(11) http://www.advisorybodies.doh.gov.uk/uksci/global/canada.htm
(12) Michael Rudnicki, CSCN Scientific Director
(13) http://www.stemcellnetwork.ca/research/index.php
(14) http://www.chinaphs.org/bioethics/regulations_&_laws.htm#_Toc113106142
(15) http://www.advisorybodies.doh.gov.uk/uksci/global/china.htm
(16) http://www.advisorybodies.doh.gov.uk/uksci/global/india.htm
(17) http://www.deccanherald.com/deccanherald/apr42005/update13039200544.asp
(18) http://stemcells.nih.gov/staticresources/research/registry/PDFs/AvailableLines.pdf
(19) http://www.academy.ac.il/bioethics/english/DocPage3-e.html
(20) http://www.advisorybodies.doh.gov.uk/uksci/global/israel.htm
(21) http://www.advisorybodies.doh.gov.uk/uksci/global/korea.htm
(22) *Science*, Apr 26, 2006
(23) http://times.hankooki.com/lpage/tech/200604/kt2006042717493811780.htm
(24) http://www.advisorybodies.doh.gov.uk/uksci/global/singapore.htm
(25)http://www.biomedsingapore.com/bms/sg/en_uk/index/research_resources/research_highlights/year_2004/pushing_the_frontiers.html)
(26) http://www.businessweek.com/magazine/content/05_02/b3915052.ht
(27) http://www.escellinternational.com/investors/overview.htm
(28) http://www.advisorybodies.doh.gov.uk/uksci/global/sweden.htm
(29) http://www.hfea.gov.uk/Home
(30) http://www.hfea.gov.uk/Research/Policy/Licensing_the_use_of_Human_Embryos.pdf
(31) http://www.advisorybodies.doh.gov.uk/uksci/uksci-reportnov05.pdf
(32) http://www.ukscf.org/
(33) http://www.ukstemcellbank.co.uk/
(34) http://www.ihr.com/infertility/provider/preimplantation-genetic-diagnosis-pgd.html