STEM CELLS AND PATENTING AND RELATED REGULATORY ISSUES: A UNITED STATES PERSPECTIVE

RAYMOND R. MANDRA AND ALICIA A. RUSSO*
Fitzpatrick, Cella, Harper & Scinto, New York

Introduction

The scientific community has discovered that stem cells, and in particular embryonic stem cells, have the potential to be used to repair or replace damaged tissues. For instance, stem cells may be used to repair spinal cord injuries and treat Parkinson's disease, diabetes, and heart failures. The potential of embryonic stem cells to repair or replace damaged tissues is based on the fact that they are primal undifferentiated cells which retain the ability to differentiate into other cell types.[1] Accordingly, it is believed that stem cells and stem cell-related inventions may represent valuable intellectual property.

Problematically, human embryonic stem cells are derived from an early stage of a human embryo and the embryo is destroyed during the embryonic stem cell isolation procedure,[2] which raises important moral and ethical issues.[3] The moral and ethical issues surrounding embryonic stem cell research are important factors to be considered when determining the value of stem cell intellectual property because, for example, these issues can affect the patentability of the invention in certain countries. In addition, government regulation of human embryonic stem cell research is highly affected by these issues. The primary focus of this article is an overview of the current state of United States patent law related to human embryonic stem cells and the regulation of human embryonic stem cell research in the United States.

The Science of Stem Cells

What are stem cells?

In order to better understand the issues related to stem cells, a basic understanding of them is useful. Stem cells are cells that have the unique potential to self-replicate for an indefinite period of time and differentiate into many specialised cell types that make up an organism.[4] Stem cells serve as a 'repair system' for the body and they proliferate without limit as long as the organism is alive to replenish damaged or aged cells.[5] Most cells in the body are specialised to perform certain functions, for example, heart cells, nerve cells and muscle cells.[6] Unlike most cells, stem cells do not have a specialised function until a signal is received by the stem cells to develop into specialised cells.[7] When a stem cell divides, each daughter cell may remain a stem cell or differentiate into a specialised cell.[8] It is these unique capabilities of stem cells to proliferate and differentiate that make them therapeutically useful in treating numerous illnesses.[9]

Embryonic stem cells are derived from a blastocyst, which is a very early stage in the development of an embryo. A blastocyst is made up of 100 to 200 cells and is shaped like a hollow sphere.[10] The inner cell mass, which is a group of cells located within the hollow sphere, is the main source of human embryonic stem cells.[11] At present, in order to start a stem cell line, the blastocyst has inevitably to be destroyed. Although new stem cell methods have been developed where the viability of the embryo may be preserved, such methods have not been performed on human embryos and effects on the embryos or the humans produced from such embryos have not been determined.[12]

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1) http://en.wikipedia.org/wiki/Stem_cell.

2) Philip M. Webber, 'Embryonic Cell Patenting'[2002/2003] 3 *Bio-Science Law Review*.

3) 'A White Paper: Alternative Sources of Human Pluripotent Stem Cells', The President's Council on Bioethics, May 2005, available at http://www.bioethics.gov.

4) 'Stem Cell information', http://stemcells.nih.gov/info/scireport chapter1.asp.

5) Ibid.

6) Ibid.

7) Ibid.

8) Ibid.

9) Ibid.

10) Philip M. Webber, Note 2 above.

11) Ibid.

12) CNN.com Report, 'New Stem Cell Methods May Avoid Embryo Destruction', http://www.cnn.com/2005/HEALTH/10/16/nature.stemcells.ap/index.html.

Categories of stem cells

There are three classes of stem cells: totipotent, pluripotent, and multipotent. A totipotent cell has the potential to develop into a complete organism.[13] An example of a totipotent cell is the zygote, or fertilised egg, which has the ability to divide and differentiate to become an organism, such as an animal or a human being.[14] A pluripotent cell has the ability to develop into any type of cell in the body; however, it lacks the ability to develop into a whole embryo.[15] A human embryonic stem cell falls into this category because it has the ability to differentiate into any one of 200 known cell types in the body.[16] It is believed that this class of stem cells holds the most promise of being able to repair or replace any damaged, diseased or destroyed cells or tissues in the body.[17] A multipotent cell has the ability to develop into a limited number of specialised cells, for example, blood cells, or bone cells.[18]

Stem cells are also categorised according to their sources: adult and embryonic. Embryonic stem cells are discussed above. Adult stem cells are unspecialised cells found among differentiated cells of a specific tissue.[19] They are mostly multipotent cells and have been used for the treatment of numerous illnesses.[20] Adult stem cells are more commonly known as somatic stem cells because they can be derived from adult human beings. Additionally, they can also be derived from children or umbilical cords.[21] It is possible that adult stem cells may hold the same promise as embryonic stem cells.

The Patentability of Stem Cell-related Intellectual Property in the United States

One criterion of patentability is defined in 35 USC § 101. It states that:

> *Whoever invents or discovers any new and useful process, machine, manufacture, or composition of matter, or any new and useful improvement thereof, may obtain a patent therefor, subject to the conditions and requirements of this title.*[22]

Title 35 of the United States Code, on its face, provides no bar on the patenting of inventions that could be considered immoral or unethical.[22a]

The United States Supreme Court has indicated that there are three categories of subject matter which are not patentable, namely 'laws of nature, natural phenomena, and abstract ideas'[23]. Although there were contentions that cells, including stem cells, are not patentable subject-matter because they constitute 'natural phenomena', the courts have stated otherwise. In *In re Bergy*, the subject-matter at issue was a purified culture of microorganism cells.[24] The court ruled that a biologically pure bacterial culture was not a 'product of nature' and thus patentable, because the culture did not exist in nature in pure form and could only be produced in a laboratory under carefully controlled conditions.[25] This notion was reconfirmed by the United States Supreme Court a few years later in *Diamond v Chakrabarty*.[26] In *Chakrabarty*, the then Chief Justice Burger, writing for the court, held that a purified culture of genetically engineered bacteria useful for cleaning up oil spills by ingesting hydrocarbons was patentable.[27] The court noted that Congress intended statutory subject-matter to 'include anything under the sun that is made by man'.[28]

The subject-matter of a purified and isolated 'product of nature' has been extended, as indicated in *Scripps Clinic & Research Found. v Genentech Inc*., to include purified and isolated DNA sequences encoding human erythropoietin ('EPO')[29] and a preparation of Factor VIII:C, used for treating hemophilia.[30] The court in *Scripps* held that 'although Factor VIII:C molecules occur in nature, a purified and concentrated preparation of Factor VIII:C as claimed in the patent constitutes a new form or combination not existing in nature, and hence is patentable under 35 U.S.C. § 101.'[31]

In January 1999, Q. Todd Dickinson, the then Acting Assistant Secretary of Commerce and Acting Commissioner of Patents

13) Note 4 above.

14) Ibid.

15) http://en.wikipedia.org/wiki/Stem_cell.

16) Note 4 above.

17) Robert C. Scheinfeld and Parker H. Bagley, 'The Current State of Embryonic Stem Cell Patents', *New York Law Journal*, September 2001.

18) Note 15 above.

19) Ibid.

20) Ibid.

21) Ibid.

22) 35 USC §101.

22a) An early judicially-created doctrine applying a morality test to patents once existed but appears to have fallen into disuse and/or was overturned *sub silentio* by the 1952 Patent Act and/or subsequent decisions. (*See, e.g. Lowell v. Lewis*, 15 F. Cas. 1018, 1019 (C.C.D Mass. 1817) (No. 8568): and *Schultz v Holtz*, 82 F 448 (N.D. Cal 1897) *cf. Ex parte Murphy*, 200 U.S.P.Q (BNA) 801, 803 (Bd.Pat App & Int 1977); and *Juicy Whip Inc v Orange Bang Inc* 51 U.S.P.Q. 2D (NBNA) 1700 (CAFC 1999).

23) *Diamond v Diehr*, 450 US 175, 185 (1981).

24) *In re Bergy*, 586 F.2d 1031 (CCPA 1977).

25) Ibid.

26) *Diamond, v Chakrabarty*, 447 US 303 (1980).

27) Ibid.

28) Ibid.

29) *Amgen Inc.v Chugai Pharmaceutical Co. Ltd*, 13 USPQ2d 1737 (D. Mass. 1989).

30) *Scripps Clinic & Research Foundation v Genentech Inc*., 666 F. Supp. 1379 (ND Calif. 1897).

31) Ibid at 1389 note 6.

and Trademarks, made a statement before the Sub-committee on Labor, Health and Human Services, Education and Related Agencies of the Senate Appropriations Committee with respect to, *inter alia*, the patenting of stem cells.[32] After discussing the background of the United States patent system, the United States patent law, the patentability of biotechnology and the cases mentioned above, Dickinson stated that it was the position of the United States Patent and Trademark Office ('USPTO') that purified and isolated stem cell lines were patentable subject-matter under 35 USC § 101.[33]

An attempt to codify the current practice of the USPTO not to allow patents covering human beings has recently been made. In early 2004, Congress passed a bill known as the Weldon Amendment which prevents the USPTO from issuing patents on a 'human organism'.[34] It was made clear that the provision would also ban patents directed to genetically engineered human embryos, foetuses and human beings but would not affect patents on genes, cells, tissue and other biological products.[35] A report accompanying the provision states that the patent ban would not interfere with stem cell research.[36] Commentary on the Weldon Amendment suggests that it appears to be in line with the Thirteenth Amendment to the US Constitution which prohibits any party from possessing property rights in a human being. The Thirteenth Amendment states:

> *Section 1. Neither slavery nor involuntary servitude, except as a punishment for crime whereof the party shall have been duly convicted, shall exist within the United States, or any place subject to their jurisdiction.*[37]

It is possible that claims directed to totipotent stem cells, that is, cells with the capability of developing into an entire human embryo and potentially a human being, might be considered non-statutory subject- matter, since such claims could be read as encompassing human beings.[38] To date, no patents have issued with claims *specifically* directed to totipotent stem cells. However, claim 1 of US Patent No. 5,843,780 ('the '780 patent'), a patent assigned to the Wisconsin Alumni Research Foundation ('WARF'), is directed to:

> *A purified preparation of primate embryonic stem cells which (i) is capable of proliferation in an in vitro culture for over one year, (ii) maintains a karyotype in which all the chromosomes characteristic of the primate species are present and not noticeably altered through prolonged culture, (iii) maintains the potential to differentiate into derivatives of endoderm, mesoderm, and ectoderm tissues throughout the culture, and (iv) will not differentiate when cultured on a fibroblast feeder layer.*[39]

Claim 1 of the '780 patent does not exclude totipotent stem cells. However, the claims in the '780 patent are directed to a *purified preparation* of primate embryonic stem cells which are capable of proliferation *in vitro* for over one year and *maintain the potential* to differentiate.[40] Such language arguably avoids any possibility that these cells could be considered to encompass cells having the ability to develop into a human being.

Although both the patentability and validity of claims directed to pluripotent stem cells (or stem cell lines) were never addressed by the courts or the legislature, there is a strong presumption made by the intellectual property community that such subject-matter is patentable, based on the numerous patents directed to pluripotent stem cells that have been issued by the USPTO within the last few years.[41]

Two key patents assigned to WARF directed to stem cells and methods for isolating such cells have been issued by the USPTO. Claim 1 of WARF's patent '780 has been discussed above. The patent also claims a method for isolating the claimed embryonic stem cells.

WARF's claim 1 of US Patent No. 6,200,806 ('the '806 patent'), states:

> *A purified preparation of pluripotent human embryonic stem cells which (i) will proliferate in an in vitro culture for over one year, (ii) maintains a karyotype in which the chromosomes are euploid and not altered through prolonged culture, (iii) maintains the potential to differentiate to derivatives of endoderm, mesoderm, and ectoderm tissues throughout the culture, and (iv) is inhibited from differentiation when cultured on a fibroblast feeder layer.*[42]

32) Statement of Q. Todd Dickinson, Acting Assistant Secretary of Commerce and Acting Commissioner of Patents and Trademarks before the Subcommittee on Labor, Health and Human Services, Education and Related *Agencies of the Senate Appropriations Committee*, http://www.uspto.gov/web/offices/ac/ahrpa/opa/bulletin/stemcell.pdf.

33) Ibid.

34) Rick Weiss, 'Hill ⟵= **Bill?**⟶Negotiators Agree to Bar Patents for Human Organisms', The Washington Post, 24 November 2003, available at http://www.washingtonpost.com/ac2/wp-dyn/A11576-2003Nov24?language=printer.

35) Ibid.

36) Ibid.

37) US Const. Amend. XIII, § 1.

38) Note 2 above.

39) US Patent No. 5,843,780 (filed 18 January 1996).

40) Ibid.

41) See, for example, US Patent No. 5,843,780 (filed 18 January 1996), US Patent No. 6,200,806 (filed 26 June 1998), US Patent No. 6,613,568 (filed 27 August 2001), US Patent No. 5,874,301 (filed 11 December 1995), US Patent No. 5,914,268 (filed 21 November 1994), US Patent No. 6,921,632 (filed 30 August 2001).

42) US Patent No. 6,200,806 (filed 26 June 1998) (*emphasis added*).

The '806 patent also claims a method of isolating the pluripotent human embryonic stem cells. Other recent related patents which claim differentiated cells derived from the pluripotent embryonic stem cells claimed in the above-mentioned patents have also been issued by the USPTO. For instance, US Patent No. 6,613,568, also assigned to WARF, claims a 'method for obtaining human hematopoietic cells, comprising exposing a human embryonic stem cell culture to mammalian hematopoietic stromal cells so as to thereby produce human hematopoietic cells'.[43]

Stem cell-related patents have also been issued by the USPTO to other entities. For instance, the National Jewish Center for Immunology and Respiratory Medicine holds at least two such patents, US Patent Nos 5,874,301 and 5,914,268 ('the '301 patent' and 'the '268 patent', respectively). The '301 patent claims

> *a pluripotent cell population wherein said cell population is transformed with a HOX11 gene, [an immortalising gene], and wherein said cell population differentiates into cellular lineages including primitive erythroid cells and definitive erythroid cells.*[44]

The '268 patent claims 'a pluripotent cell population that is pluripotent for development into [lymphoid and hematopoetic cells]'. The cell population of the '268 patent is derived from an embryoid body cell population under conditions comprising embryonic blast cell medium.[45]

Not only has the USPTO issued stem cell-related patents to American entities, it has also issued such patents to foreign entities. For instance, US Patent No. 6,921,632 (the '632 patent) is assigned to Maria Biotech Co, Ltd of Seoul, Korea.[46] The '632 patent is directed to a process for making undifferentiated human embryonic stem cells, comprising the steps of thawing a cryopreserved human blastocyst embryo, isolating the inner cell mass, and culturing at least a portion of said inner cell mass on a medium capable of sustaining the undifferentiated embryonic stem cells.[47]

Thus, even with the controversies surrounding the subject-matter of human embryonic stem cells, such cells are viewed by the USPTO as patentable subject-matter and, as can be seen in its practice, the USPTO continues to issue patents having claims directed to embryonic stem cells. This practice is in accordance with *Ex parte Murphy* which states that the USPTO can make no social or moral judgment regarding the patentable utility of inventions.[48] Accordingly, it is expected that the USPTO shall continue issuing such patents unless an exception is made for human cell cultures through legislation or the courts.

The Regulation of Human Embryonic Stem Cell Research

As indicated in the above discussion, it appears that the USPTO views at least human pluripotent embryonic stem cells as patentable subject-matter and that patents shall continue to issue with claims directed to the cells and the related technology and methodology. There is no federal law that prohibits the use of embryos in stem cell research. However, there are federal policies and legislation that impede human embryonic stem cell research by restricting federal support for such research.

One such policy is President Bush's 9 August 2001 policy announcement that federal funds are only available for embryonic stem cell research using only the 60 embryonic stem cell lines derived prior to 9 August 2001.[49] This limitation does not apply to research performed by the private sector. However, it is believed by at least one commentator that any federally funded inventions that arise in violation of this restriction would be deemed to be unpatentable on grounds of public welfare.[50] The Bush policy further indicates that such research must also satisfy these criteria: (1) there must have been informed consent of the donor;, (2) the embryos must have been created for reproductive purposes and be in excess of clinical need; (3) there must not have been any financial inducement to the donors; and (4) the embryos must not have been created for research purposes.[51] As of August 2005, there are only 22 presidentially approved viable cell lines available for funded research use.[52]

The President's announcement was met with great opposition by the biotechnology community because it was viewed as a major constraint to the advancement of human embryonic stem cell research.[53] However, the President's Council on

43) US Patent No. 6,613,568 (filed 27 August 2001).

44) US Patent No. 5,874,301 (filed 11 December 1995).

45) US Patent No. 5,914,268 (filed 21 November 1994).

46) US Patent No. 6,921,632 (filed 30 August 2001).

47) Ibid.

48) *Ex parte Murphy*, 200 USPQ 801 (BPAI 1977) (concluding that '[the USPTO] should not be the agency which seeks to enforce a standard of morality . . . by refusing on the ground of lack of patentable utility . . . if the requirements of the Patent Act otherwise have been met.')

49) Sheryl G. Stolberg, 'THE PRESIDENT'S DECISION: A QUESTION OF RESEARCH; Disappointed by Limits, Scientists Doubt Estimate of Available Cell Lines', *New York Times*, 10 August 2001, available at http://query.nytimes.com/gst/health/article-page.html?res=9A04E3DC123FF933A2575BC0A9679C8B63.

50) Note 2 above.

51) http://www.whitehouse.gov/news/releases/2001/08/20010809-2.html.

52) Alan Boyle, 'Bush's Bioethicist on Stem Cell Alternatives: Council Chairman Reflects on Science and Morality on Medical Frontier', http://www.msnbc.msn.com/id/8842556.

53) Note 49 above.

Bioethics, a panel of ethicists, scientists, lawyers, doctors, and professors appointed by the President to advise on bioethical issues related to advances in biomedical science and technology, presented in May 2005 a report called 'A White Paper: Alternative Sources of Human Pluripotent Stem Cells'. The panel for the White Paper evaluated four alternative sources of stem cells.[54] These alternatives included: (1) pluripotent stem cells derived from organismically dead embryos; (2) pluripotent stem cells obtained via blastomere extraction from living embryos which may not impair the viability of the embryos; (3) cells derived from specially engineered biological artifacts; and (4) pluripotent stem cells obtained by somatic cell dedifferentiation.[55] The panel determined that the first and the last proposals are ethically acceptable for humans and rejected the remaining two as morally objectionable.[56]

Even before the President's statement, Congress has since 1996 attached a rider to legislation that limits the National Institutes of Health funding. The rider, an amendment coined the 'Dickey Amendment', named after the Representative who introduced it, Jay Dickey, prohibits the Department of Health and Human Services from using appropriated funds for the creation of human embryos for research purposes or for research in which human embryos are destroyed.[57] Congress has continued to limit such funding through the fiscal year of 2006.[58]

At present, there is no federal law regulating privately funded research on human embryos and human embryonic stem cells. Interestingly, in 2005, a number of bills were introduced to the House of Representatives relating to the loosening of federal regulation of stem cell research. The Stem Cell Research Enhancement Act of 2005, introduced on 15 February 2005 to amend the Public Health Service Act, would relax the President's policy by permitting the Secretary of the Department of Health and Human Services to conduct and support research utilising human embryonic stem cells, regardless of the date of derivation, as long as the following requirements are met:[59] (1) the stem cells must have been derived from embryos created for the purposes of fertility treatment and be in excess of clinical need; (2) prior to the consideration of embryo donation, it must be determined that the embryo will never be implanted in a woman and would otherwise be discarded; and (3) the individuals seeking fertility treatment must have donated the embryos with written informed consent and without receiving any financial or other inducement to make the donation.[60] Not surprisingly, strong support for this bill comes from biotechnology trade organisations, such as the Biotechnology Industry Organization and the Coalition for the Advancement of Medical Research, a non-partisan non-profit organisation comprised of nationally recognised patient organisations, universities, and foundations. The House passed this bill in May 2005 and it has been introduced to the Senate. Although it appeared that the Senate would act on and likely pass the bill in October 2005, voting will not take place until 2006, largely due to Hurricane Katrina disaster relief and Harriet Mier's Supreme Court nomination.[61] However, President Bush has promised to veto the bill if it is passed by Congress. Both the Senate and the House would have to obtain more supporting votes in order to override his veto.

In addition, on 2 February 2005, the Cord Blood Stem Cell Act of 2005 was introduced to amend the Public Health Service Act.[62] A similar bill, the Bone Marrow and Cord Blood Therapy and Research Act of 2005, was also introduced.[63] Both bills are now before the Senate. The bills would direct the Secretary of the Department of Health and Human Services to establish and maintain a National Network of Cord Blood Stem Cell Banks to: (1) acquire, tissue type, test, cryopreserve, and store donated units of human cord blood acquired with the informed consent of the donor in a manner that complies with federal and state regulations; (2) make cord blood units available to transplant centres for stem cell transplantations; (3) allocate cord blood inventory each year for peer-reviewed research; and (4) encourage donation from genetically diverse populations.[64] There are also provisions setting forth reporting requirements, facilitating access to under-represented populations, and establishing and maintaining the National Bone Marrow Donor Registry to include cord blood.[65] The bills provide for the collection and maintenance of cord blood units for the treatment of patients and research, and to amend the Public Health Service Act to authorise the Bone Marrow and Cord Blood Cell Transplantation Program to increase the number of transplants for recipients suitably matched to donors of bone marrow and cord blood.[66]

54) Note 3 above.

55) Ibid.

56) Ibid.

57) Departments of Labor, Health and Human Services, and Education, and Related Agencies Appropriations Act of 2006, HR 3010, 109th Cong. (2005). The rider can be found in Title V, section 509.

58) Ibid.

59) HR 810/S. 471, 109th Cong. (2005).

60) Ibid.

61) Laurie Kellman, 'Senate May Postpone Stem Cell Vote Until Next Year', The Associated Press, 20 October 2005.

62) HR 596/S. 681, 109th Cong. (2005).

63) HR 2520/S. 1317, 109th Cong. (2005).

64) HR 596/S. 681, 109th Cong. (2005);.. 2520/S. 1317, 109th Cong. (2005).

65) HR 596/S. 681, 109th Cong. (2005);.. 2520/S. 1317, 109th Cong. (2005).

66) HR 596/S. 681, 109th Cong. (2005); HR 2520/S. 1317, 109th Cong. (2005).

On 14 April 2005, the Stem Cell Research Investment Act of 2005 was introduced to amend the Internal Revenue Code.[67] The bill provides a tax credit to an entity holding a qualified stem cell research bond issued by a state or local government.[68] A qualified stem cell research bond is a bond issued where 95 per cent or more of the proceeds are to be used for interdisciplinary scientific and medical research relating to stem cells, therapy development of stem cells, and development of pharmacology and treatments through clinical trials relating to stem cells.[69] Thus, this bill could be viewed as indirect federal funding of unrestricted stem cell research. The bill is currently before the House Committee on Ways and Means.

In an apparent effort to continue to address moral and ethical concerns, the Human Cloning Ban and Stem Cell Research Protection Act of 2005 was introduced on 21 April 2005 to amend the Federal Food, Drug, and Cosmetic Act.[70] The provisions state that it shall be unlawful to: (1) conduct or attempt to conduct human cloning; (2) ship the product of nuclear transplantation in interstate or foreign commerce for the purpose of human cloning in the United States or elsewhere; or (3) export to a foreign country an unfertilised blastocyst if such country does not prohibit human cloning.[71] In addition, the bill proposes an amendment to the Public Health Service Act regulating research involving nuclear transplantation.[72] It prohibits: (1) the transplantation of a somatic cell nucleus into a human oocyte that has undergone or will undergo fertilization; (2) the maintenance of an unfertilised blastocyst after more than 14 days from its first cell division, not counting any time during which it is stored at temperatures less than zero degrees centigrade; (3) the use of an oocyte in nuclear transplantation research unless such oocyte has been donated voluntarily and with informed consent of the donor; (4) the acquisition, receipt, or transferring of a human oocyte or unfertilised blastocyst for valuable consideration if the transfer affects interstate commerce; and (5) the conducting of nuclear transplantation in a laboratory in which human oocytes are subject to assisted reproductive technology treatments or procedures.[73] The bill has been referred to the Senate Committee on the Judiciary.

Similarly, the Respect for Life Embryonic Stem Cell Act of 2005 was introduced on 24 May 2005 to amend the Public Health Service Act.[74] It provides means to support research on animals to investigate alternative sources of stem cells.[75] A similar bill, the Respect for Life Pluripotent Stem Cell Act of 2005, was introduced on 30 June 2005.[76] These bills promote the development of ethical techniques to create and study pluripotent stem cells using animals, but they would prohibit any research that would harm or destroy a human embryo.[77] The bills were sent to subcommittees in both the House and the Senate.

The Joe Testaverde Adult Stem Cell Research Act of 2005 was introduced on 23 May 2005.[78] It would require the Director of National Institutes of Health ('NIH') to provide funding for at least five centres of excellence to conduct basic and clinical research regarding qualifying adult stem cells, that is, human stem cells obtained from a human placenta, umbilical cord blood, an organ or tissue of a living or deceased human being who has been born, or an organ or tissue of unborn human offspring who died of natural causes.[79] The bill would also require the NIH to provide for a programme 'under which samples of tissues and genetic materials that are of use in qualifying adult stem cell research are donated, collected, preserved, and made available for such research'.[80] The bill has been referred to the House Committee on Energy and Commerce.

The Cures Can Be Found Act of 2005 was introduced to the House on 26 July 2005 to provide a tax credit for investments and donations to promote adult and umbilical cord blood stem cell research and a $2,000 tax credit to individuals donating cord blood that can be used to extract stem cells.[81] The bill has been referred to the House Committee on Ways and Means.

More aggressive bills have also been introduced. For example, the Stem Cell Replenishment Act of 2005 was introduced on 4 January 2005.[82] The provisions of this bill would lift the ban on funding for projects that use embryonic stem cell lines derived after 9 August 2001.[83] The bill has been referred to the House Committee on Energy and Commerce.

67) HR 1650, 109th Cong. (2005).
68) Ibid.
69) Ibid.
70) HR 1822/S. 876, 109th Cong. (2005).
71) Ibid.
72) Ibid.
73) Ibid.
74) HR 2574, 109th Cong. (2005).
75) Ibid.
76) HR 3144/S. 1557, 109th Cong. (2005).
77) Ibid.
78) HR 2541, 109th Cong. (2005).
79) Ibid.
80) Ibid.
81) HR 3444, 109th Cong. (2005).
82) HR 162, 109th Cong. (2005).
83) Ibid.

All of the bills mentioned above, especially the Stem Cell Research Enhancement Act of 2005 which provides for indirect federal funding, are high on Congress's agenda this year.

The Roles of the States

Research on human embryonic stem cells is also the subject of state regulations; and there are significant variations between states.

California leads the states in supporting stem cell research. It is the only state in which the constitution contains any stem cell research-related provisions and it was the first state to enact laws that expressly encourage research involving the derivation of embryonic stem cells and cloned embryos.[84] Proposition 71, also known as the 'California Stem Cell Research and Cures Act', was adopted in November 2004 and incorporated as Article 35 of the California Constitution.[85] The goals of the Act include improving the California health care system, benefiting the state budget, and advancing the California biotechnology industry.[86] Proposition 71 also provides for the establishment of the California Institute for Regenerative Medicine ('CIRM') and allocates approximately $300 million annually in bonds over a ten-year period for stem cell research.[87] CIRM is a state agency that awards grants and provides loans for stem cell research, research facilities, and other vital research opportunities. The state assembly has also appointed the California Council on Science and Technology which partners with CIRM to create intellectual property policies for technology arising from Proposition 71.[88] Although the policy has yet to be ironed out, it is believed that California will establish a royalty revenue system to ensure a return on their investment and take advantage of its position as leader in the field.[89]

New Jersey became the second state, after California, to legislate to promote human embryonic stem cell research. New Jersey legislature has declared stem cell research, including somatic cell nuclear transplantation to be permitted in the state.[90] The legislation, along with the creation of the New Jersey Stem Cell Institute in January 2005 and a $230 million bond referendum on the ballot in November 2005 to fund stem cell research grants over the next ten years, has put New Jersey on the map with California as a stem cell research centre.[91] However, New Jersey's early start may soon stall, because the funds to build the New Jersey Stem Cell Institute are not available and the bond referendum has been pushed back.[92]

On 17 November 2004, Wisconsin Democratic Governor Jim Doyle announced a $750 million biotechnology, health science, and stem cell plan, including $375 million for a research institute to be housed on the University of Wisconsin's Madison Campus.[93] Governor Doyle introduced a proposed state budget, which also includes funding of embryonic cell research.[94] There are no bills currently pending in the Wisconsin legislature that relate to stem cells.

In February 2005, Maryland lawmakers introduced legislation providing state funding for embryonic stem cell research.[95] The Maryland Stem Cell Research Act of 2005 allows the state to fund research that utilises adult and embryonic stem cells.[96] As amended, the bill only permits the use of surplus embryos from fertility clinics, not the use of embryos produced through therapeutic cloning.[97] It also proposes that the funding for the research should come from a settlement with the tobacco industry.[98]

In Massachusetts, both the State Senate and the House of Representatives passed at least one similar bill in late March 2005 in support of embryonic stem cell research.[99] The Republican Governor of Massachusetts, Mitt Romney, opposed and vetoed the bill. However, his veto was overridden by the legislature on 31 May 2005.[100] Although the new bill does not provide any research funds, the leader of the Massachusetts Senate is expected to introduce a companion bill that would appropriate about $100 million for stem cell research.[101]

The Connecticut State Senate has also approved funding for stem cell research with House Bill No. 5912, also known as An

84) Cal. Health and Saf. Code, §§ 125115-119, 125290-292, and 125300-320 (2005). See, for example, §§ 125118 and 125118.5.

85) Cal. Const. Article XXXV, §§ 1-7 (2005).

86) Ibid.

87) Ibid.

88) 'Stem Cell Initiative Poses Challenges', CCST Report, 10, 1 (2005), available at http://www.ccst.us/ccst/pubs/nwsltr/v10i1/v10i1.html#2.

89) Ann L. Gisolfi and Anthony M. Insogna, 'States Fund Stem Cell Research; As a Result of Federal Financing Limits, Several States Have Stepped In', Nat. Law J., 13 June 2005 at S1.

90) N.J. Stat. Ann. §§ 26:2Z-1-2Z-2 (2005).

91) Ibid.

92) Tina Kelley, 'In Race Toward First Stem Cell Research Institute, New Jersey Stalls', *New York Times*, 31 July 2005 at sect. 1, p. 25.

93) Press release, Office of the Governor Jim Doyle, 'Governor Doyle Outlines Wisconsin's Strategy to Remain at the Forefront of Biotechnology, Health Sciences, and Stem Cell Research', 17 November 2004, available at http://www.wisgov.state.wi.us/journal_media_detail_print.asp?prid=832.

94) bid.

95) S. 751, 2005 Gen. Assem., 42th Sess. (Md. 2005), unofficial copy.

96) Ibid.

97) bid.

98) Ibid.

99) S. 2039, 184th Gen. Ct. of the Commonwealth of Mass. (Mass. 2005).

100) Raphael Lewis, 'Stem Cell Bill Override Turns Talk to Research Support', *The Boston Globe*, 1 June 2005 at Metro/Region Sect., p. A1.

101) Ibid.

Act Promoting Stem Cell Research in the State.[102] The bill provides $100 million over a period of ten years in a Stem Cell Research Fund to be administered by Connecticut Innovations, Inc., a quasi-public agency that will provide investment capital and encourage collaboration between academia and businesses.[103]

On 12 July 2005, Illinois Democratic Governor Rod Blagojevich signed an executive order to allocate $10 million to stem cell research.[104] The Governor inserted the funds as a single line into the Illinois Department of Public Health budget.[105] The Illinois state legislature defeated several stem cell research measures while in session in spring 2005.[106] Governor Blagojevich has thus taken a bold move despite Republican opposition to stem cell research.[107]

The New York State Assembly also has several pieces of legislation that relate to stem cell research. The bills provide for $100 million to fund the establishment of the New York State Institute for Stem Cell Research, the promotion of human embryonic stem cell research and the donation of cord blood as a source of stem cells, while prohibiting reproductive cloning.[108] None has been passed by the legislature.

On 11 October 2005, a coalition of researchers and patient groups in Missouri proposed a constitutional amendment to protect stem cell research.[109] The goal of the coalition's proposal is to protect patients' rights to be treated with any eventual stem cell-related cures.[110] It would also specify that stem cell research, therapies and cures allowed under federal law will be permitted in Missouri.[111] Republican Governor Matt Blunt supports this proposal.[112]

Although several states have shown support for stem cell research, there are a number of states that have passed legislation or have pending bills that prohibit or limit stem cell research funding. They include, among others, Indiana, Michigan, Mississippi, Nebraska, Kansas and Virginia.

Conclusion

As can be seen from the practice of the USPTO, it appears that pluripotent, and possibly totipotent,[113] embryonic stem cells are considered patentable subject-matter. It is expected that more patents will be issued directed to stem cell-related subject-matter. Up until now, the USPTO has not issued patents with claims which specifically relate to totipotent stem cells. This may be due to the fact that totipotent stem cells raise a red flag because they could be read as encompassing cells that can develop into a human organism and thus considered to be a non-statutory subject-matter.

While there clearly is the possibility of protecting significant advances in the stem cell arena through the use of the US patent system, the volume of that protection will be highly dependent on the direction of the future regulation of stem cell research. What is not clear is the ultimate direction that stem cell research regulation will take.

Currently, there is no federal law that prohibits the use of embryos in stem cell research. However, there are federal policies and legislations that limit the funding of such research. A number of bills have been proposed in Congress to relax the policies and legislation. Supporters of stem cell research have high hopes that these bills will be passed by Congress in the near future. Several states have shown support and provided funding to advance stem cell research. However, there are also a number of states that do not support stem cell research; some even plan to prohibit such research. It is expected that decisions made by federal and state legislatures in the near future will shed light on the direction of stem cell research.

102) HB 5912, 2005 Gen. Assem. (Conn. 2005).

103) Ibid.

104) John Chase, 'Governor Slips Stem-Cell Grant by Lawmakers; Illinois Joins States Opposing Bush Stand', *Chicago Tribune*, 13 July 2005 at News Sect., p. 1.

105) Ibid.

106) Ibid.

107) Ibid.

108) Summary results of Bill Search on New York State Assembly website, http://assembly.state.ny.us.

109) David A. Lieb, 'Missouri Initiative Proposed to Protect Stem Cell Research', The Associated Press, 13 October 2005.

110) Ibid.

111) Ibid.

112) Ibid.

113) As long as the claims relating to the totipotent stem cells cannot read on a human organism. See text accompanying notes 34 to 37 above.