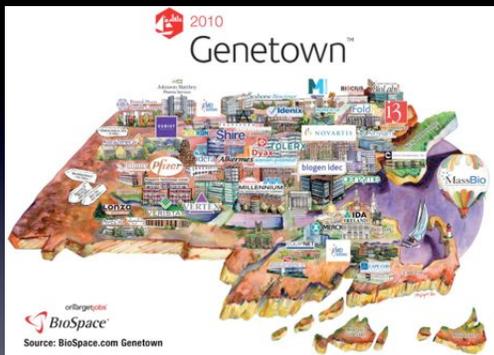


## Stem cells, regenerative medicine, and clusters of innovation in the Asia-Pacific region

William Hoffman  
 Laboratory Medicine & Pathology  
 University of Minnesota Medical School  
 MBBNet.umn.edu

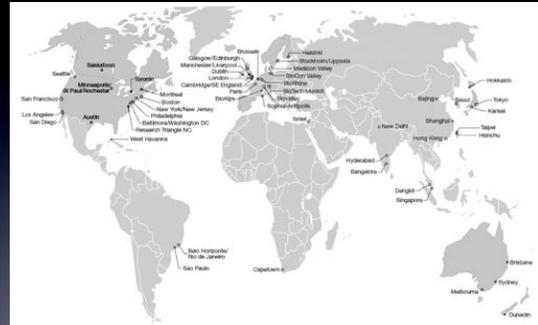
World Stem Cells and Regenerative Medicine Congress Asia  
 Seoul, South Korea  
 October 28, 2010

## Regenerative medicine and geographic clusters -- linking the ingredients of bioscience innovation



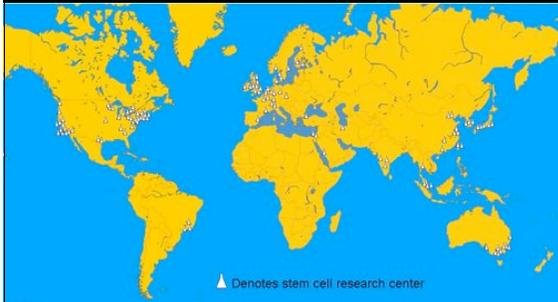
"Clusters are geographic concentrations of interconnected companies, specialized suppliers, service providers, and associated institutions in a particular field that are present in a nation or region." Institute for Strategy and Competitiveness, Harvard Business School

## Global Bioscience Clusters



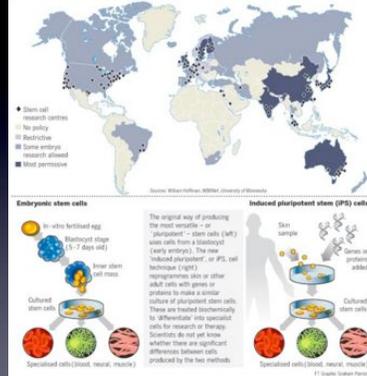
Map by William Hoffman modified from original map published in "More Than the Sum of Their Parts? Clustering is becoming more prevalent in the biosciences, despite concerns over the sustainability and economic effectiveness of science parks and hubs" by Andrea Rinaldi, EMBO reports, February 2006.

## Global Stem Cell Research Centers



Map by William Hoffman. Global clustering of stem cell research centers and institutes. The United Kingdom, Singapore, South Korea and China are investing heavily in the embryonic stem cell field.

## Global culture



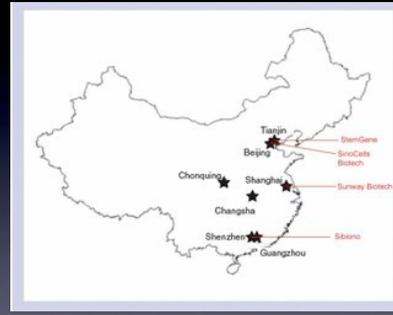
Financial Times, June 25, 2009

## Stem Cell Research in Asia-Pacific

Country	Estimated size of community	Stem Cell Society	Major research centers	Human embryonic stem cell banks
Australia	~600	Australasia Society for Stem Cell Research (ASSCR)	Australia Stem Cell Centre, Australia Regenerative Medicine Institute, Australia Tissue Engineering Centre, Monash University and other national universities	None
China	500+	China Society for Stem Cell Research (CSSCR)	CAS (Beijing, Shanghai, Guangzhou), Jiaotong University and Peking University	Four (Beijing, Tianjin, Shanghai, Guangzhou)
India	~100	Stem Cell Research Forum of India	Center for Cellular and Molecular Biology (CCMB), Christian Medical College (CMC), National Center for Biological Sciences (NCBS) and Tata Institute of Fundamental Research (TIFR)	One (under construction; NCCS, Pune)
Japan	~300		RIKEN CDB, Kyoto University Institute of Cell Engineering and Meso Sciences, other national and private universities (Tokyo, Keio)	One (RIKEN Bioresources Center, Tsukuba)
Singapore	~100	Stem Cell Society Singapore (SCSS)	A*STAR (IMCS, IMB, GIS) and National University of Singapore	One (Singapore Stem Cell Bank)
South Korea	~700	Korean Society for Stem Cell Research (KSSCR)	National Stem Cell Center, Seoul National University and Cha Stem Cell Institute	One (National Stem Cell Research Center, Seoul)
Taiwan	~500	Taiwan Society for Stem Cell Research (TSSCR)	Academia Sinica, National Yang Ming University and National Health Research Institutes	One (Taiwan Stem Cell Bank)
Thailand	~50		Mahidol University and Chulalongkorn University	None

From Douglas Sipp, "Stem cells and regenerative medicine on the Asian horizon: An economic, industry and social perspective," *Regenerative Medicine* 4 (6) 911-918, 2009.

## Centers of Regenerative Medicine in China



Map modified from Fig. 2 of "Cultivating regenerative medicine innovation in China," McMahon, Thorsteinsdóttir, Singer & Daar, *Regenerative Medicine* 5 (1), 2010.



[www.asiapacificstemcells.org](http://www.asiapacificstemcells.org)

Creating bioartificial organs from stem cells -- moving from the laboratory to start-up



## Regenerative Medicine: From the Lab to the Start-up

Quick Tissue™ and a decompressor are needed to see this picture.

"Perfusion-decellularized matrix: using nature's platform to engineer a bioartificial heart," Harald C. Ott et al., *Nature Medicine*, Jan. 13, 2008.

## Regenerative Medicine: From the Lab to the Start-up

United States Patent Application	20090202977
Kind Code	A1
Ott; Harald ; et al.	August 13, 2009
<b>DECELLULARIZATION AND RECELLULARIZATION OF ORGANS AND TISSUES</b>	
Abstract	
The invention provides for methods and materials to decellularize a solid organ and to recellularize such a decellularized organ to thereby generate a solid organ.	
Inventors:	Ott; Harald; (Boston, MA); Taylor; Doris; (St. Paul, MN)
Correspondence Name and Address:	FISH & RICHARDSON P.C. PO BOX 1022 MINNEAPOLIS MN 55408-1022 US
Assignee Name and Address:	REGENTS OF THE UNIVERSITY OF MINNESOTA St. Paul MN

Patent filed with the USPTO August 28, 2006

Regenerative Medicine: Miromatrix Medical, Inc.

Heart Liver  
Lung Kidney

[www.miromatrix.com](http://www.miromatrix.com)

"The breadth and depth of the applications for the Miromatrix technology is staggering. It will enable the replacement of entire organs (e.g. heart; liver; kidney; pancreas) with non-transplantable organs harvested from either animals or donors, stripped of their cells and recellularized with either cells from the recipient or compatible cells. The potential market for the Miromatrix organ replacement technology is enormous...." Miromatrix Medical, Inc.

Regenerative Medicine: Recreating the Lung

Orthotopic transplantation of a regenerated left lung construct. Harald C. Ott et al., "Regeneration and orthotopic transplantation of a bioartificial lung." *Nature Medicine*, July 13, 2010.

Regenerative Medicine: Recreating the Lung

"Development of a Decellularized Lung Bioreactor System for Bioengineering the Lung: The Matrix Reloaded," Andrew Price et al. *Tissue Engineering*, May 21, 2010

Stem cell research and globalization--  
a look at the dynamics of policy, publications,  
patents, and investment

Human Embryonic Stem Cell Research Policy

Countries with a permissive or flexible policy on embryonic stem cell research in brown  
• Denotes genome-sequencing center

MBBNet.umn.edu/scmap.html

Map by William Hoffman. Countries in brown represent 3.8 billion people. Those in light brown allow research on IVF donations. Those in dark brown also allow nuclear transfer / research cloning. All have banned human reproductive cloning.

Human Embryonic Stem Cell Research Policy: *Financial Times*

FT.com Map Source: William Hoffman (MBBNet)

FINANCIAL TIMES THURSDAY JULY 20 2006

THE AMERICAS

**Bush's veto of embryo stem cell law marks turning point with Congress**

By Holly Thayer in Washington

President George W. Bush's veto of a bill to allow federal funding for embryonic stem cell research is a landmark move that will reshape the debate over the use of embryos in research.

Republicans - who had previously supported the bill - are now opposed to it. The move is seen as a victory for the pro-life lobby, which has long opposed the research.

Democrats, who had previously opposed the bill, are now in support of it. The move is seen as a victory for the pro-science lobby, which has long supported the research.

Embryonic stem cell research is a controversial area of science. It involves the use of embryos, which are the earliest stage of human development. Some people believe that embryos have the potential to become human beings, and therefore they should not be used for research.

Others believe that embryos are just a cluster of cells, and therefore they can be used for research. The debate over the use of embryos in research has been ongoing for many years.

The bill that President Bush vetoed would have allowed federal funding for embryonic stem cell research. This would have been a significant step towards the development of new treatments for a wide range of diseases.

However, the bill also would have allowed federal funding for research on the creation of embryos for research purposes. This is a more controversial area of research, and it is one that has been banned in many countries.

President Bush's veto of the bill is a clear statement of his opposition to the use of embryos in research. It is a move that will have a significant impact on the future of stem cell research in the United States.

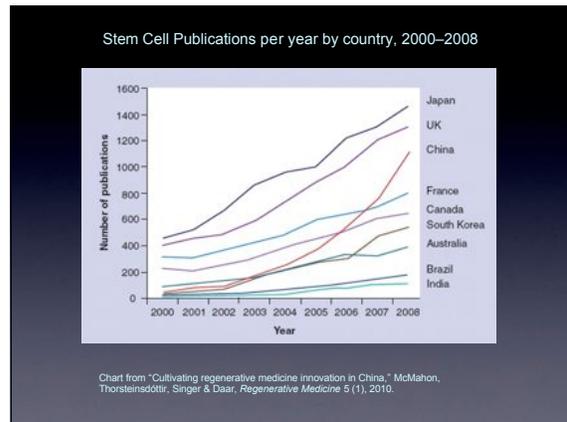
Bloomberg.com Business Exchange

**Bloomberg Businessweek**

**Eye on Asia**

**U.S. Stem Cell Ruling May Boost Asian Research**

Posted by: Bruce Einhorn on August 24, 2010



Stem Cell Publications by Country, 2001–2009

Country	Number of stem cell publications
Australia	663
China	946
India	157
Japan	2,852
Korea	703
Singapore	180
Taiwan	225
Thailand	31
England	1,863
Germany	2,594
Israel	408
Canada	996
USA	9,468

From Douglas Sipp, "Stem Cell Research in Asia: A Critical View," *Journal of Cellular Biochemistry* 107: 853–856, 2009.

Stem Cell Patents

**NATURE BIOTECHNOLOGY** Volume 28 Number 7 July 2010

**Table 1:** Recent patent applications in stem cells

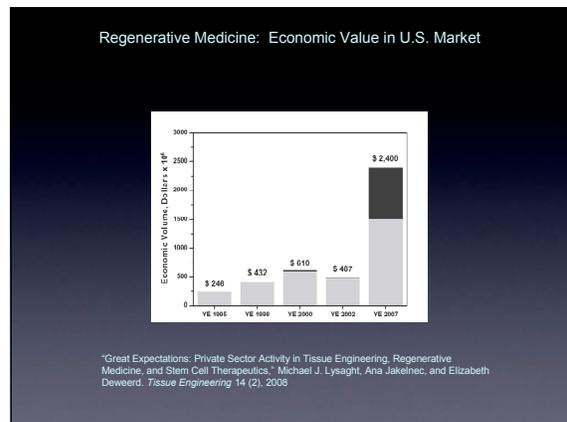
Patent no.	Assignee	Inventor	Priority app date	Pub date
WO 201000266	Zhejiang University Science & Technology Ltd. (Shanghai)	Zhou M	11/28/2008	6/3/2010
WO 2010059738	US Department of Health & Human Services (Washington, DC)	Freed WJ, Vazin T	11/18/2008	5/27/2010
WO 2010059965	Regents of the University of California (Oakland, CA, USA)	Carlson ME et al.	11/24/2008	5/27/2010
WO 2010060031	Anthrogenesis (Warren, NJ, USA)	Falick H et al.	11/21/2008	5/27/2010
US 2010057965	Techion Research & Development Foundation	Amit M, Itskovitz-Eldor J	10/7/2002	5/27/2010
US 20100129907	Crooks G, Evseevko D	Crooks G, Evseevko D	7/2/2008	5/27/2010
WO 2010057965	Project Science to Technology (Madrid)	Gonzalez Galvez B et al.	11/20/2008	5/27/2010
CN 101705288	The Institute of Radiology & Radiation Medicine of the Academy of Military Medical Science of China (Beijing)	Guo Z et al.	9/29/2009	5/19/2010
CN 101705289	Zhejiang University (Hangzhou, China)	Chen X et al.	12/15/2009	5/19/2010
KR 2010051195	Seoul National University Research & Development Business Foundation (Seoul)	Kang KS, Park JR	11/7/2008	5/17/2010
KR 2010047742	Bio Spectrum (Gunpo-si, Korea)	Lee JH, Lee JS, Park D	10/29/2008	5/10/2010

iPS Cell Patents

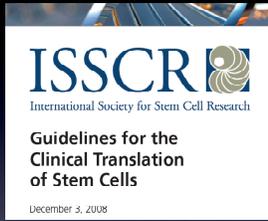
**NATURE BIOTECHNOLOGY** Volume 28 Number 1 January 2010

**Table 1:** Recent patent applications in induced pluripotent stem (iPS) cells

Patent no.	Assignee	Inventor	Priority application date	Publication date
WO 2009137624	Advanced Cell Technology (Worcester, MA, USA)	Lanza R, Lu S	5/6/2008	11/12/2009
WO 2009138867	Agency for Science, Technology & Research (Singapore)	Feng B, et al.	5/6/2008	11/12/2009
WO 2009137629	Advanced Cell Technology (Worcester, MA, USA)	Lanza R, Lu S	5/6/2008	11/12/2009
US 20090280096	Bonham K et al., Vertex Therapeutics (S. San Francisco, CA, USA)	Bonham K, et al.	5/9/2008	11/12/2009
JP 2009254340	Nagai K, Japan	Nagai K	4/19/2008	11/5/2009
WO 2009133971	Kyoto University (Kyoto, Japan)	Okita K, Yamnaka S	5/2/2008	11/5/2009
WO 200913262	Mirae Biotech (Seoul, Japan)	Jeon K, Kim EY, Park S P	4/25/2008	10/29/2009
WO 2009128533	Nagoya University Corp., Nagoya University (Aichi, Japan)	Niwaawa N, Toriashi S	4/18/2008	10/22/2009
WO 2009122747	Kyoto University (Kyoto, Japan), Tokyo University (Japan)	Eto K, et al.	4/1/2008	10/8/2009
WO 2009140655	Primmgen Biotech (Irvine, CA, USA)	Janer C, et al.	5/15/2008	5/15/2009

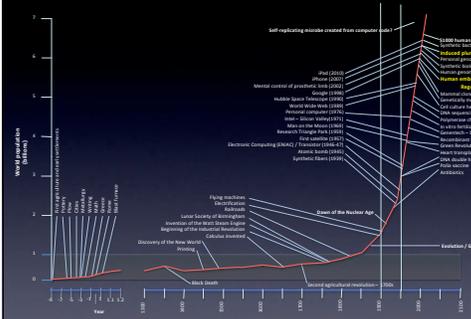


International Society for Stem Cell Research



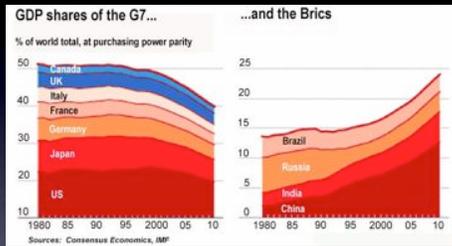
The challenges of developing stem cell therapies into an accepted standard of medical practice "underscore the need for independent expert peer review prior to clinical investigation to ensure the integrity of the research and informed consent processes."

Innovation: The Multi-Millennial Journey



Modified from Fig. 1, "Catching up with the Economy," Robert W. Fogel, *American Economic Review*, March 1999. With the assistance of James Hudak.

Global Shares of GDP: G7 and the Brics



From Martin Wolf, *Financial Times*, Feb. 2, 2010. By 2030, the IMF forecasts that the Asian GDP will exceed that of the Group of Seven (G7) industrialized economies.

# Asia Leading the Way

Asia is moving into a leadership role in the world economy.

**T**he 2008 report which has predicted the emergence of Asia as a global economic superpower. Several countries in the region are generating growth increases that rival or exceed those of the world economy. China and India are leading the way, but the momentum is being picked up by other Asian economies. Asia's economic importance is increasing rapidly. Asia's economic importance is increasing rapidly. Asia's economic importance is increasing rapidly.

International Monetary Fund, June 2010