

# Applications of Biotechnology / Bioengineering (Chapter 11)

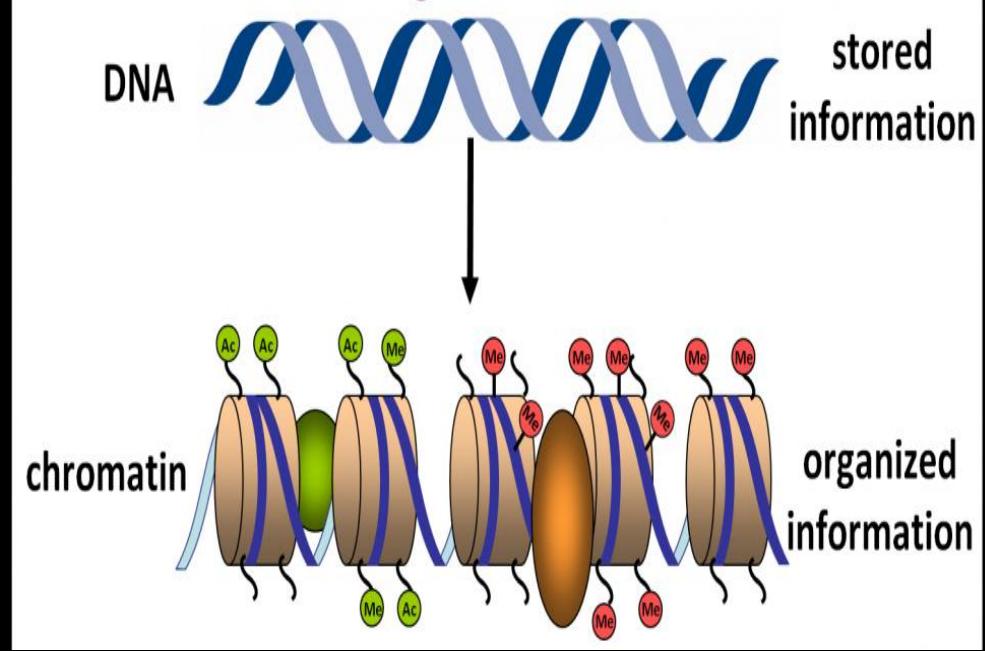


## Genetic Potential of Cells - Stem Cells

# Welcome to the Fascinating World of



**Reproductive Cloning and Stem  
Cells (Chapter 11)**



**What is the chromatin pattern  
in that differentiated cell?**

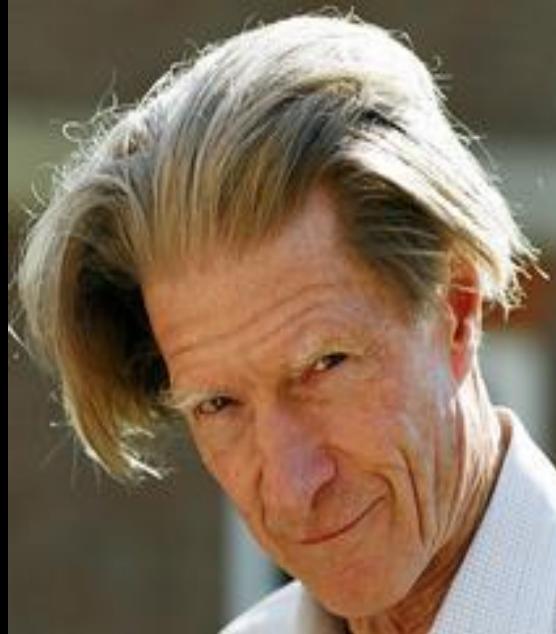


**Can we re-programme it  
back?**

**If so what can be the  
advantage?**

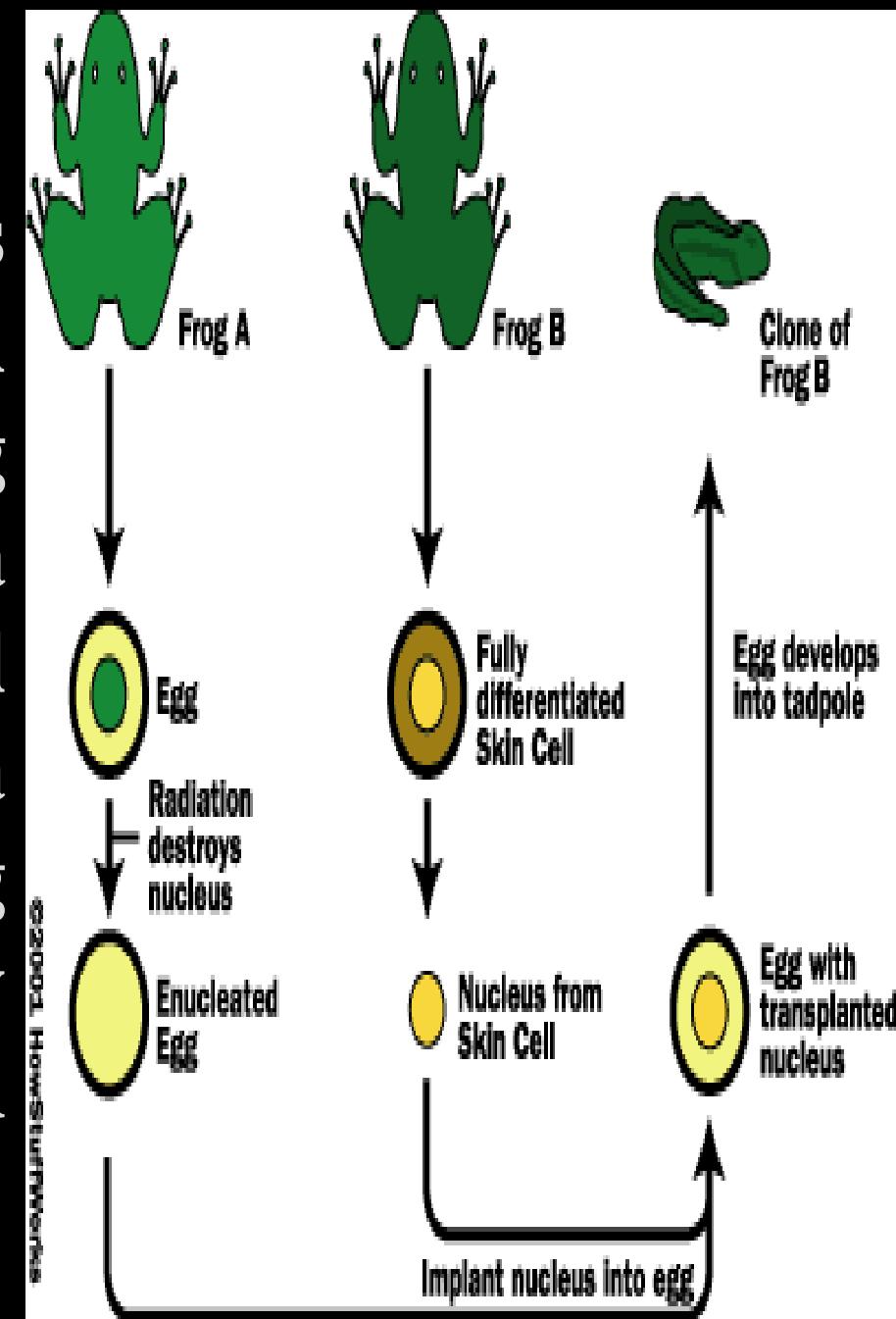
1962.....

1st Time: mature cells  
reprogrammed to early state

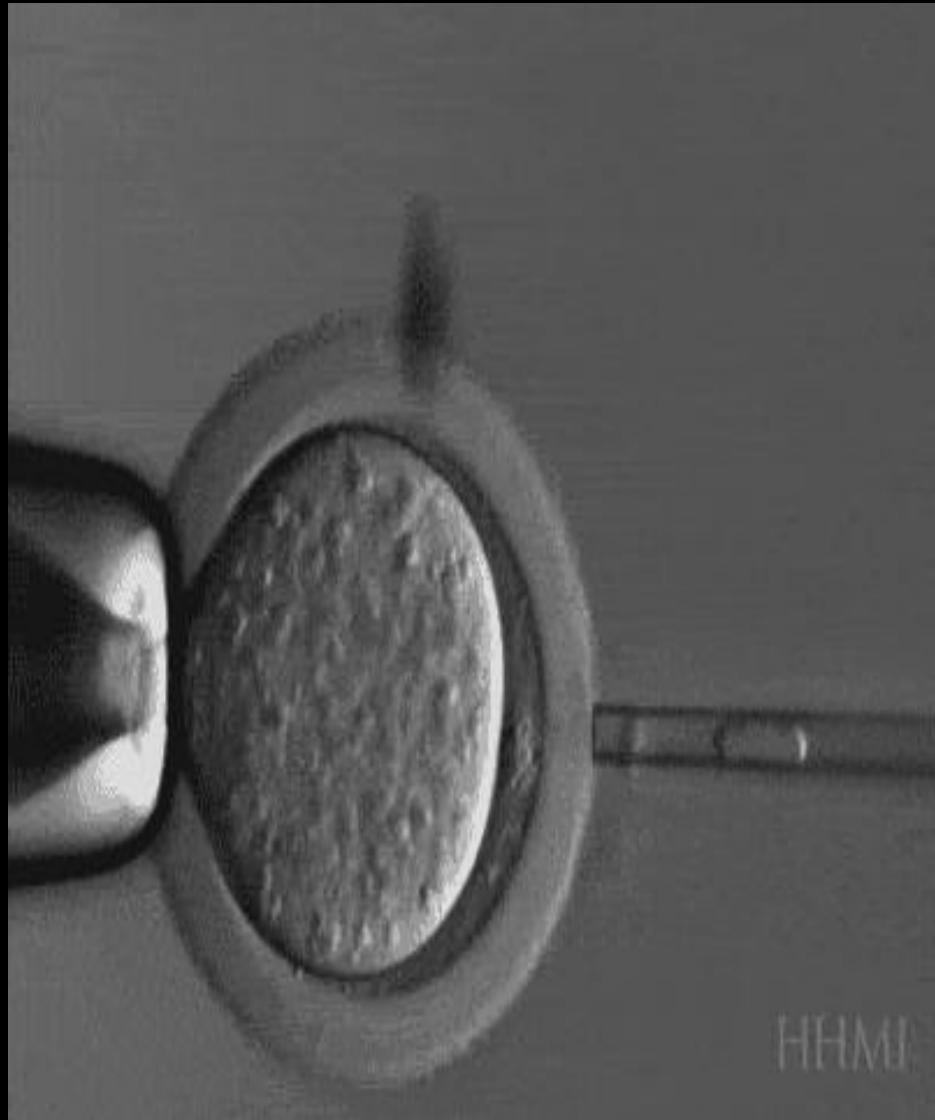
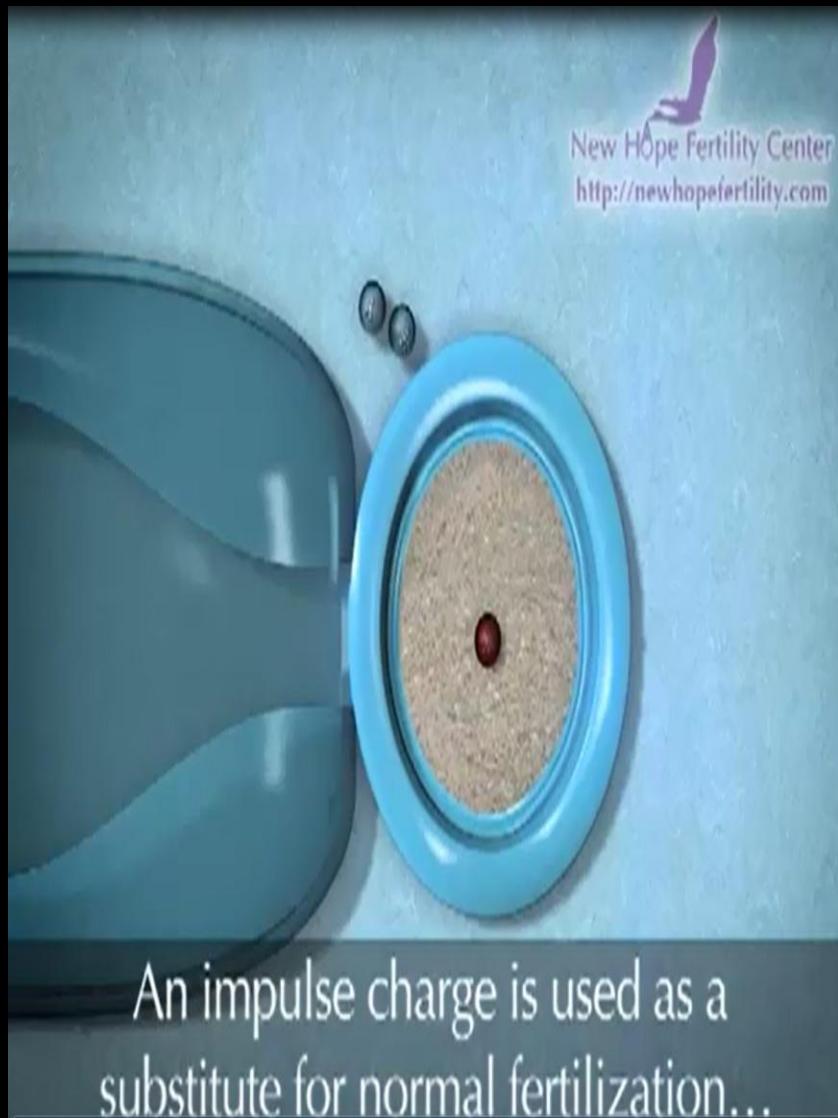


Frogs jump back wards in development: John B. Gurdon, University of Cambridge, challenged the dogma that a specialized cell is irreversibly committed to its fate.

He tested this hypothesis by replacing the cell nucleus of a frog's egg (**n**) with a nucleus from a mature, specialized cell (**2n**) derived from a tadpole. The egg developed into a fully functional, cloned tadpole.



# (Somatic Cell Nuclear Transfer)



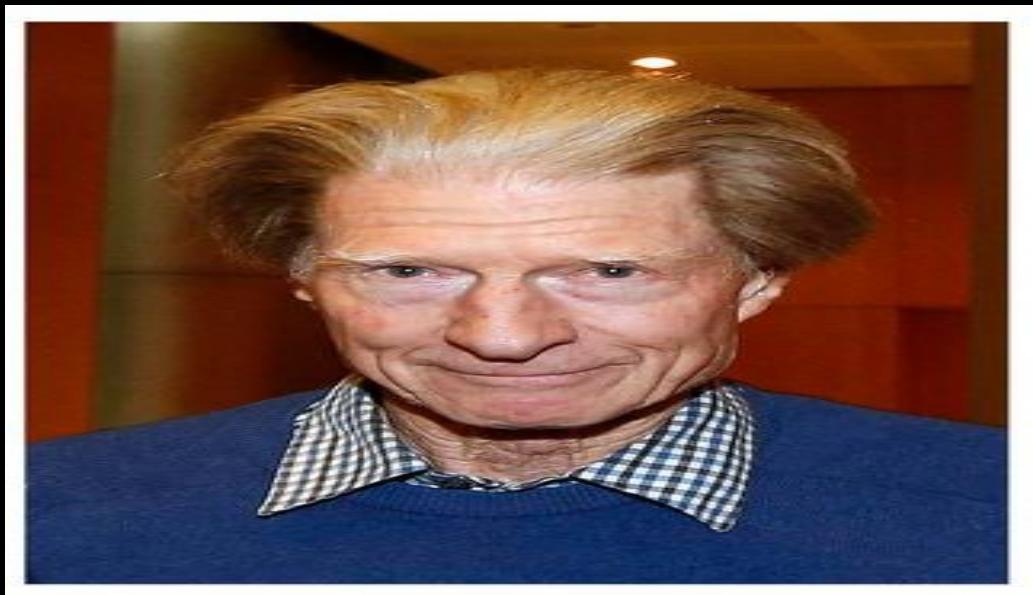
# The 2012 Nobel Prize in Physiology or Medicine

Mature differentiated cells can be reprogrammed to become early state cell:

**Dr. John B. Gurdon**

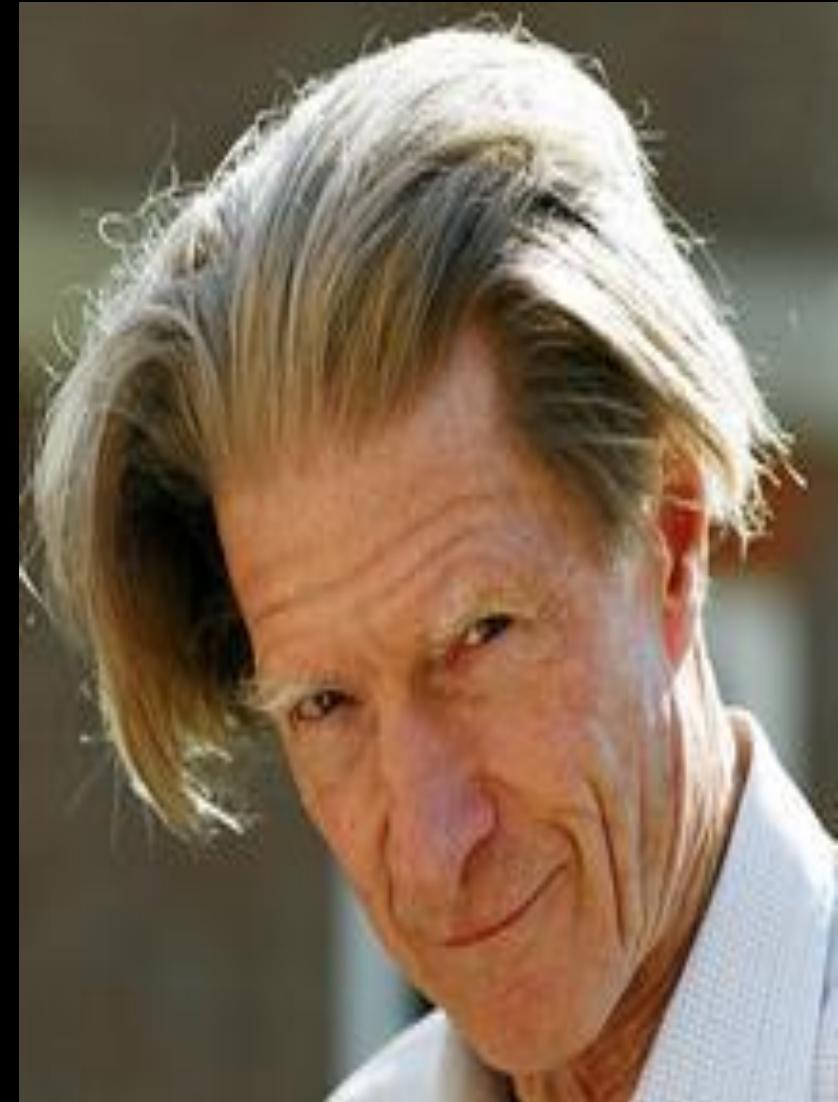


# **His Teacher says.....**



**Dr. Gurdon's early academic career did not hint at what the future might hold. "I believe Gurdon has ideas about becoming a scientist; on his present showing this is quite ridiculous," his high school biology teacher wrote. "If he can't learn simple biological facts he would have no chance of doing the work of a specialist, and it would be a sheer waste of time, both on his part and of those who would have to teach him."**

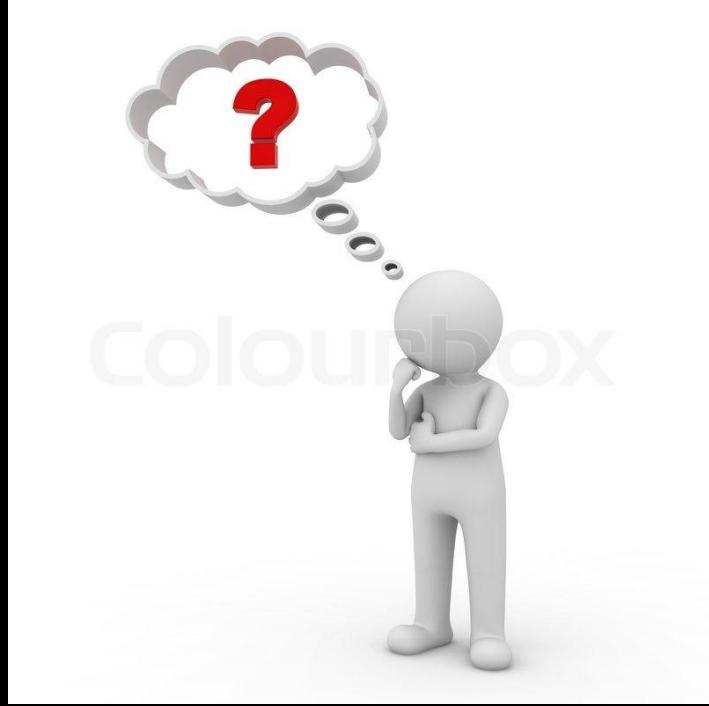
1962.....



# 1997.....

- Scottish researchers cloned the first mammal in **1997 (Dr. Ian Wilmut)**.
  - **Dolly** (July 5, 1996 - February 14, 2003) the sheep.
- The procedure that produced Dolly is called **Reproductive Cloning**.





# Why take G<sub>0</sub> cells for SCNT?



**Why should there be a surrogate mother in cloning? Why cant the genetic donor carry her own baby?**

# The 1<sup>st</sup> Cloned Bison



**Gaur**

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2001, ACT, USA, Died in 48hrs

# Wild Sheep



**Mouflon calf with mother**

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2001, Italy

# Wild Cattle



**Banteng**

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2003, Iowa

# Wild Mountain Goat



2009, Spain, Pyrenean ibex,  
1<sup>st</sup> time an Extinct Animal was cloned

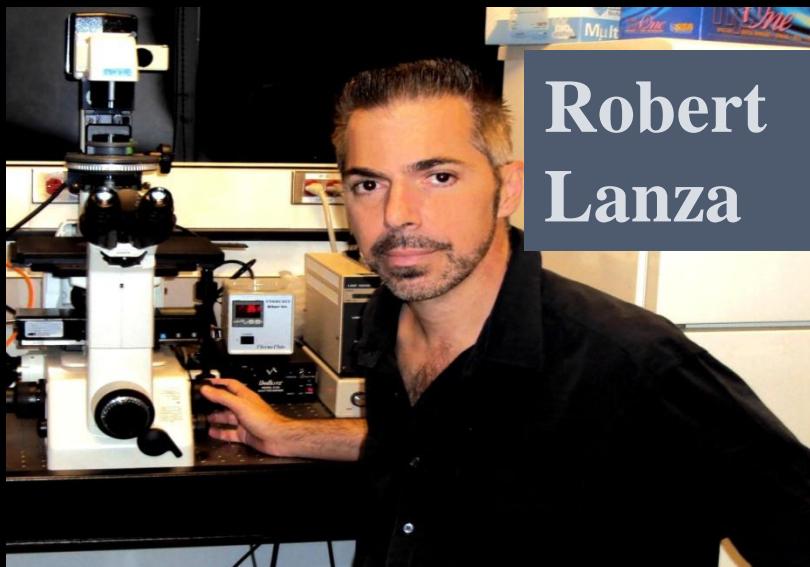
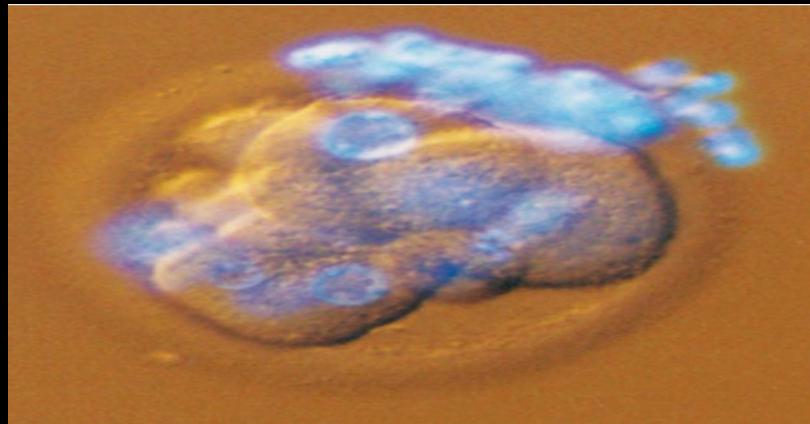
# Cloned Buffalo



“GARIMA” 6<sup>th</sup> June 2009, India

# Human Cloning; not a Science Fiction anymore

- First cloned human embryo (2001), a research company, **Advanced Cell Technology (ACT)** in, Worcester, MA, USA.
- Stopped dividing after the first few divisions (6 cell stage)



Robert  
Lanza

# THE GREAT STEM CELL DEBATE



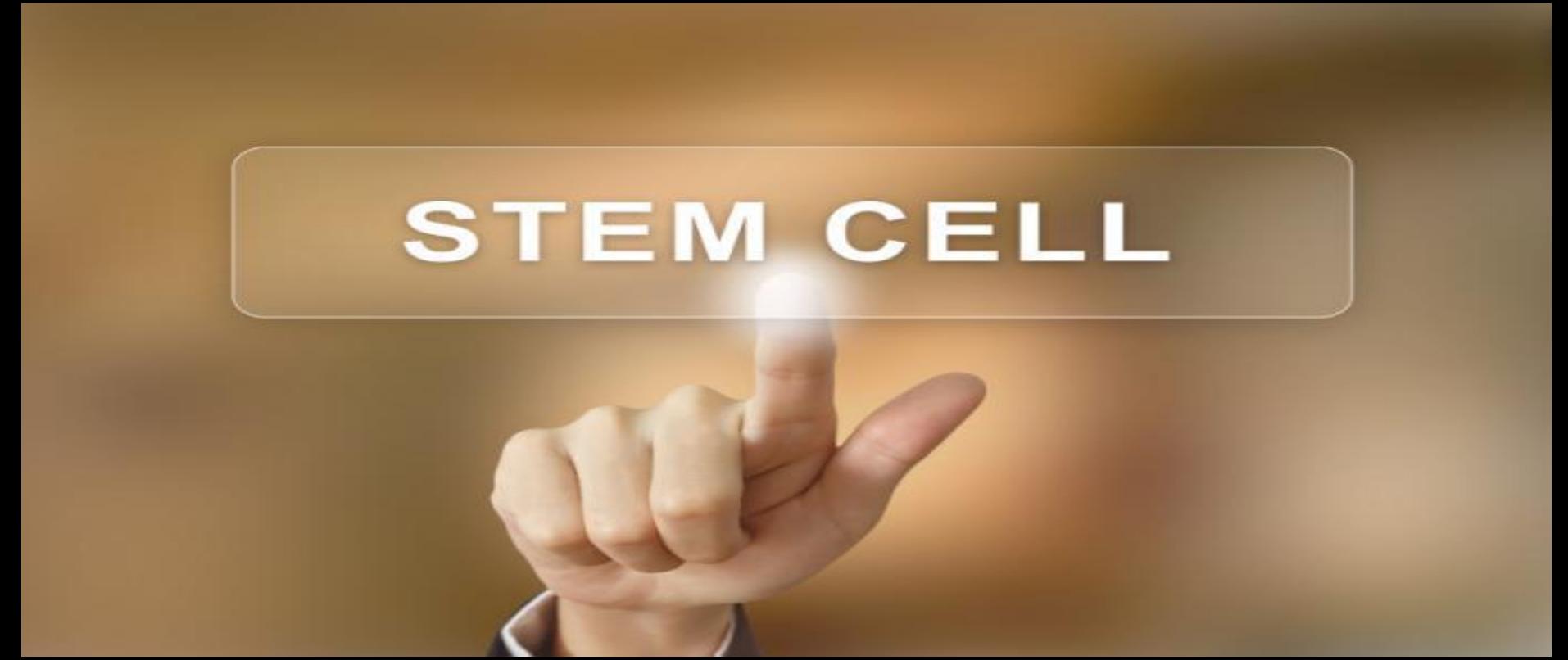
# Should we clone humans?



# Issues with Reproductive Cloning

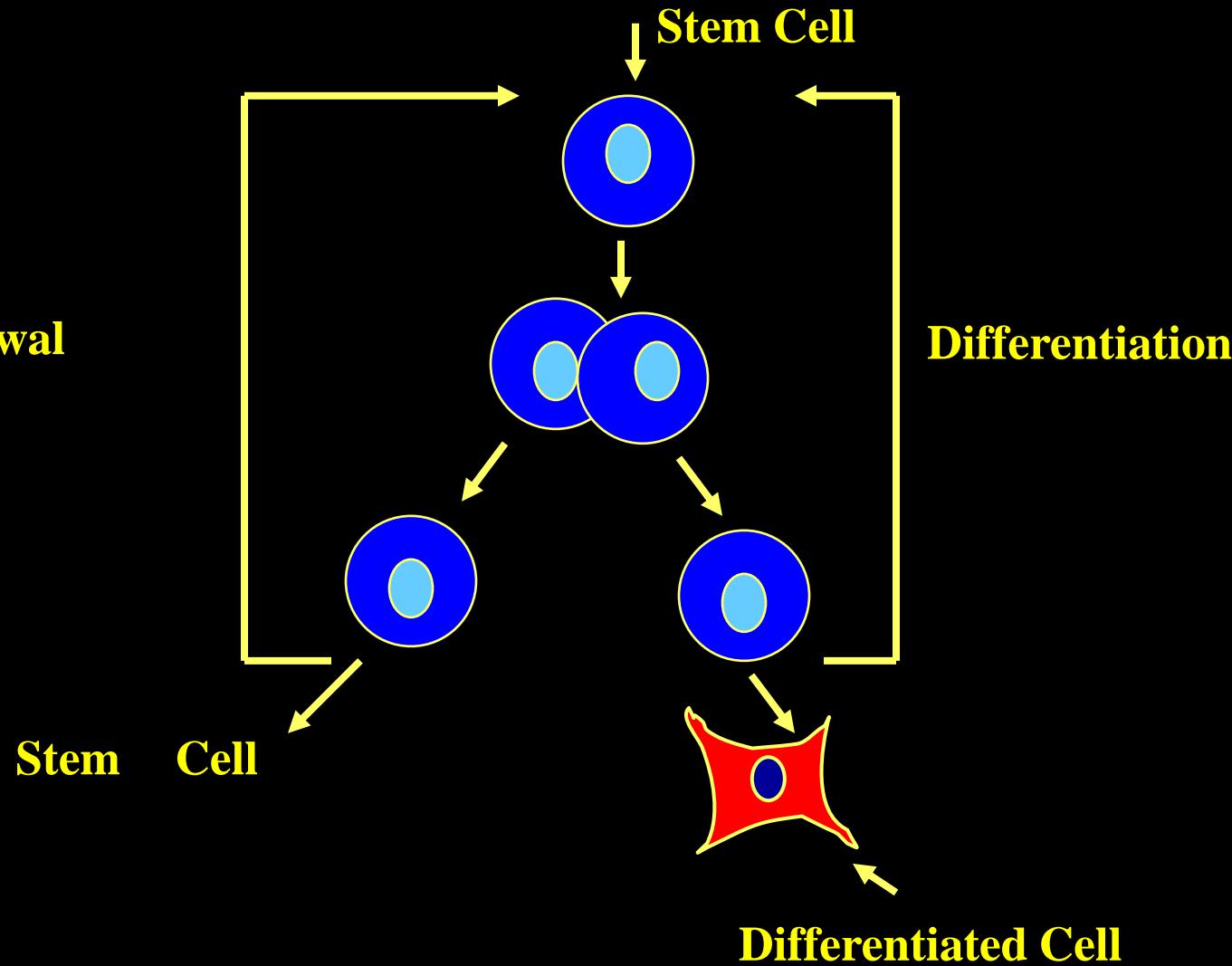
- The success rate ranges from 0.1 percent to 3 percent
- Premature ageing
- Development of diseases
- Not really a copy of the original
- Ethical issues

**When re-programming is done which  
cell type it resembles?**

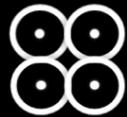
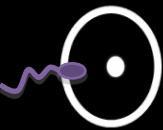


**STEM CELL**

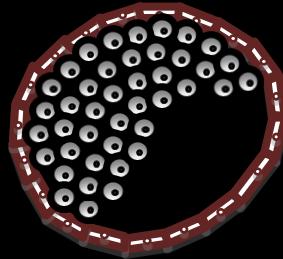
# What makes a cell a Stem Cell?



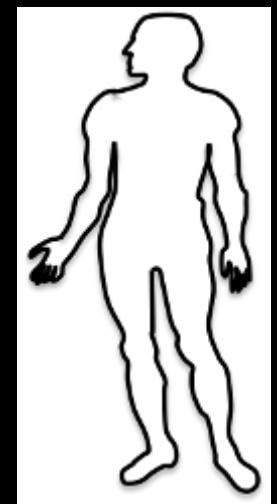
# Where are stem cells found?



**Embryonic stem cells**  
**blastocyst - a very early**  
**embryo**

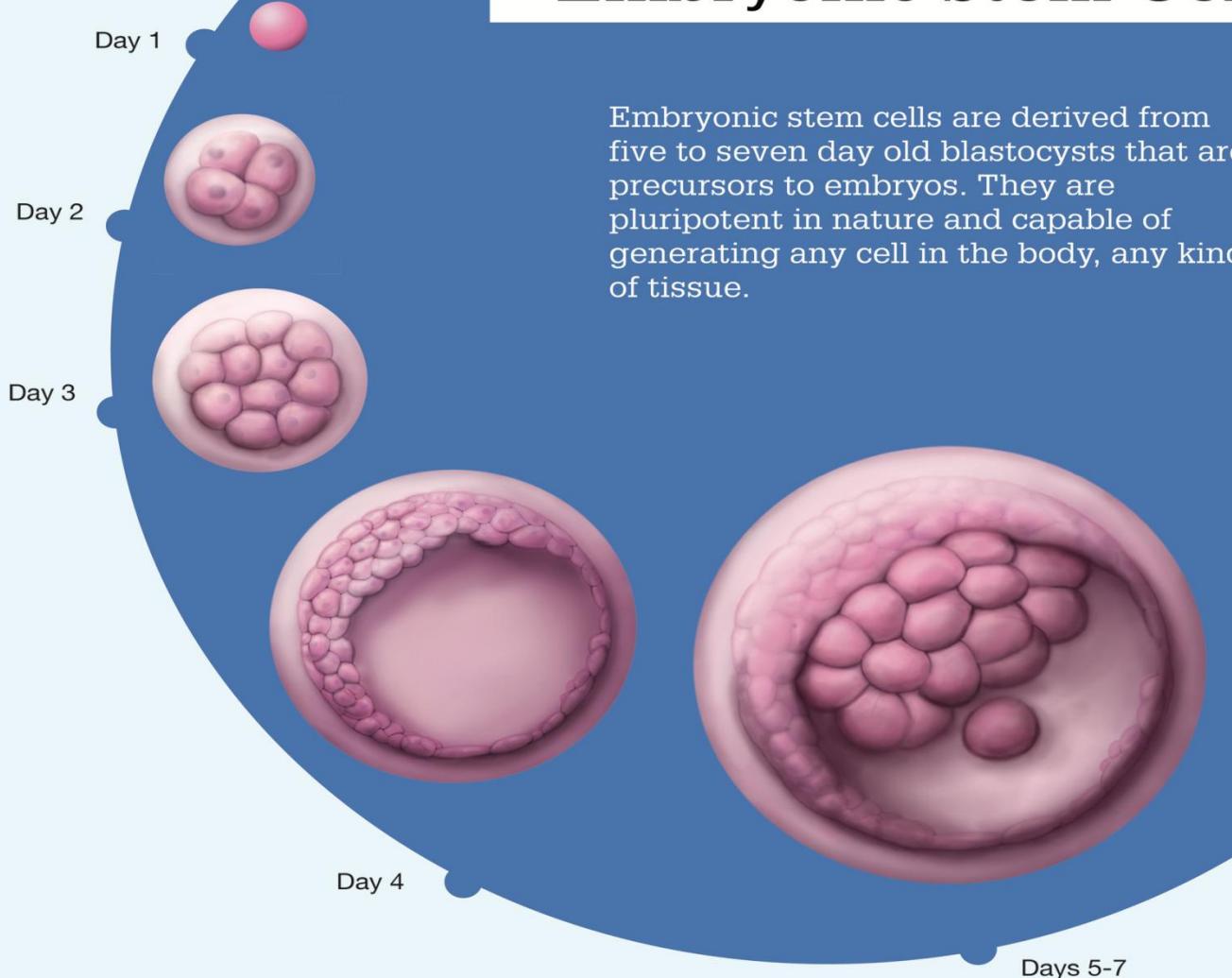


**Tissue/Adult stem cells**  
**fetus, baby and throughout life**



# Embryonic Stem Cells

## Embryonic Stem Cells



# Do You Have... Heart Failure?



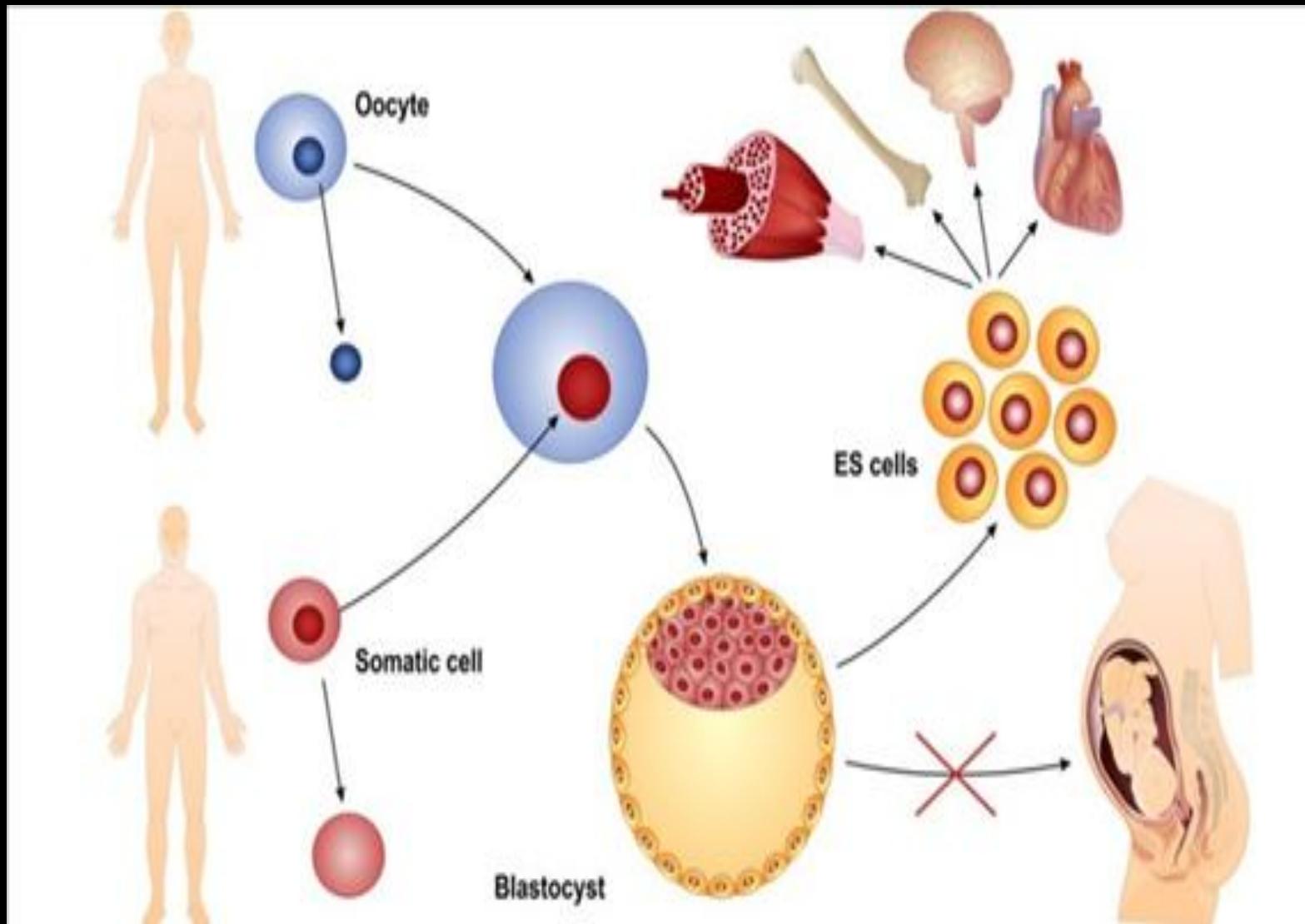
TEXAS HEART® INSTITUTE

**STEM CELL CENTER**

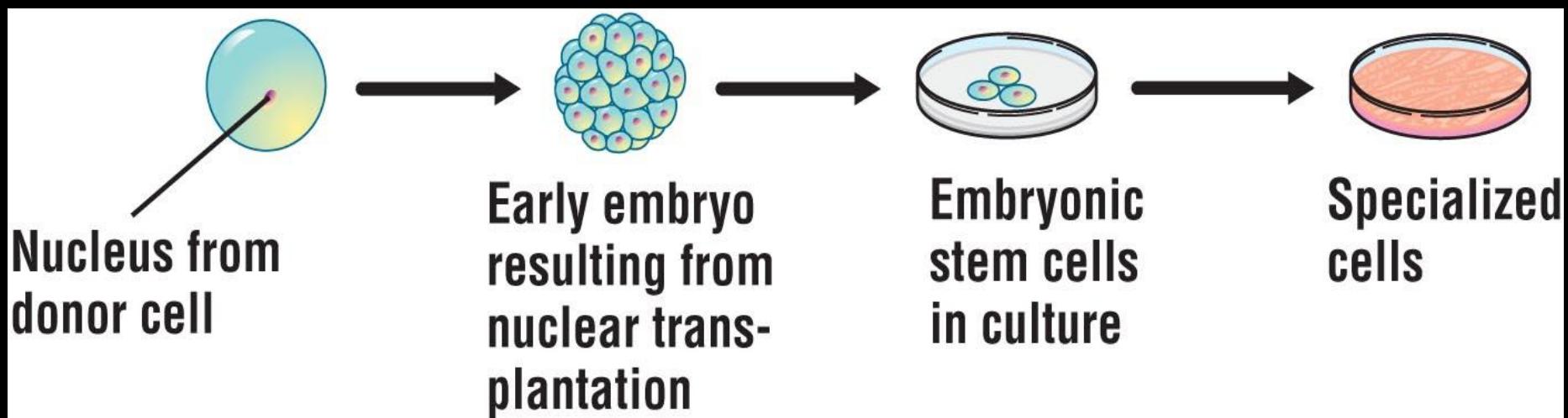
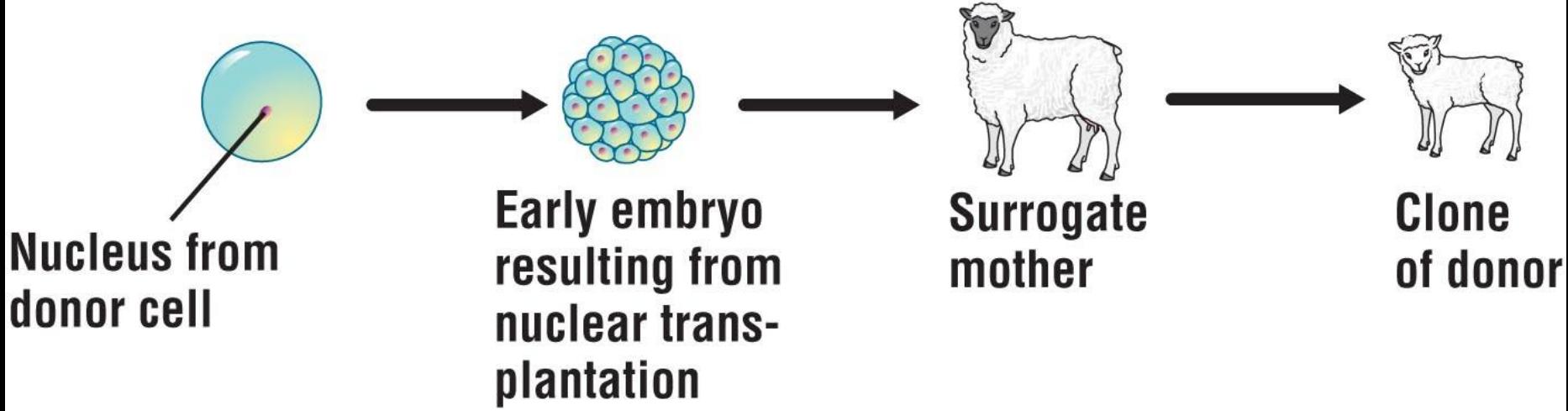
is screening for eligible patients with these  
cardiovascular conditions for

**clinical trials using adult stem cells**

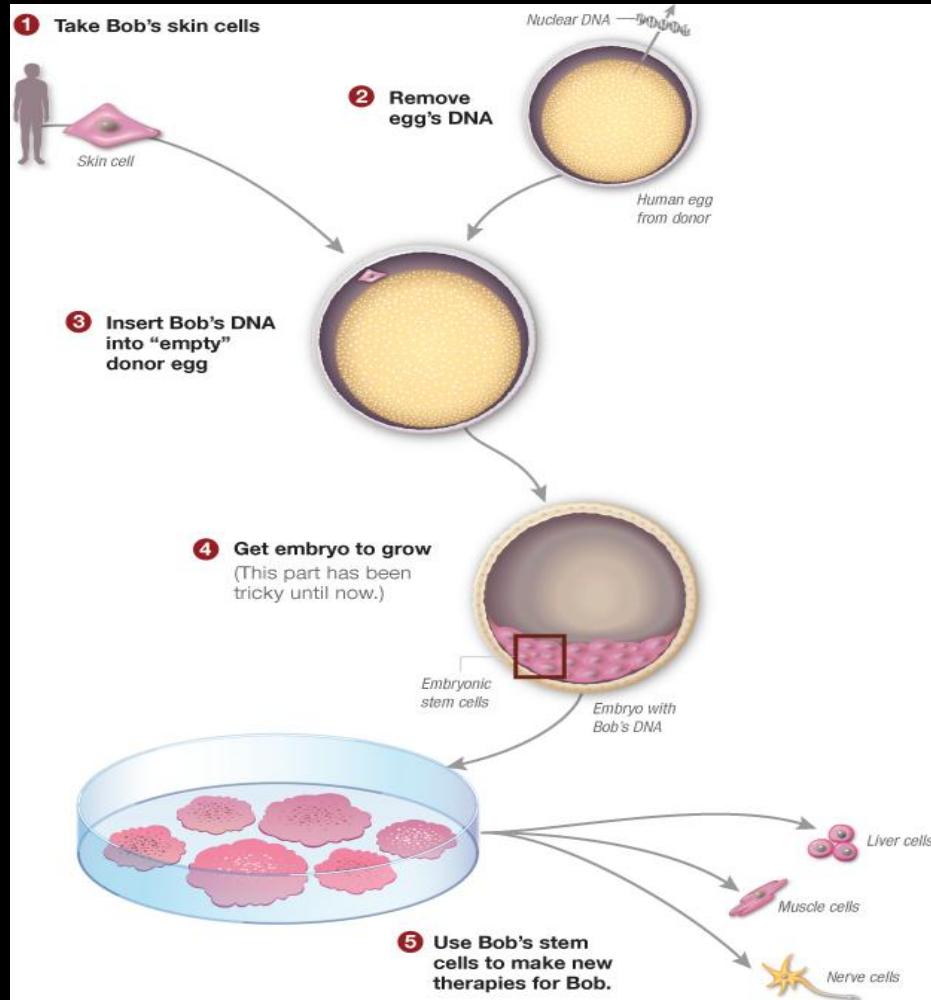
# Therapeutic Cloning



# Reproductive vs Therapeutic



# Scientist Clone Human Embryos To Make Stem Cells (2013)



Making Personalized Stem Cells



Dr Mitalipov of the Oregon Health & Science University says that they have, for the first time, cloned human embryos capable of producing embryonic stem cells

Nature in everything demands respect...



Ethical restrictions from using  
fertilized human embryo

**Adult cells are less ethically  
problematic than ES cells**

# The 2012 Nobel Prize in Physiology or Medicine

A portrait photograph of Shinya Yamanaka, a man with short dark hair and glasses, wearing a dark blue suit jacket over a light blue striped shirt.

Core researcher  
**Shinya Yamanaka**  
Director, Center for iPS Cell Research and Application (CiRA),  
Kyoto University

[Website of the professor ▶](#)

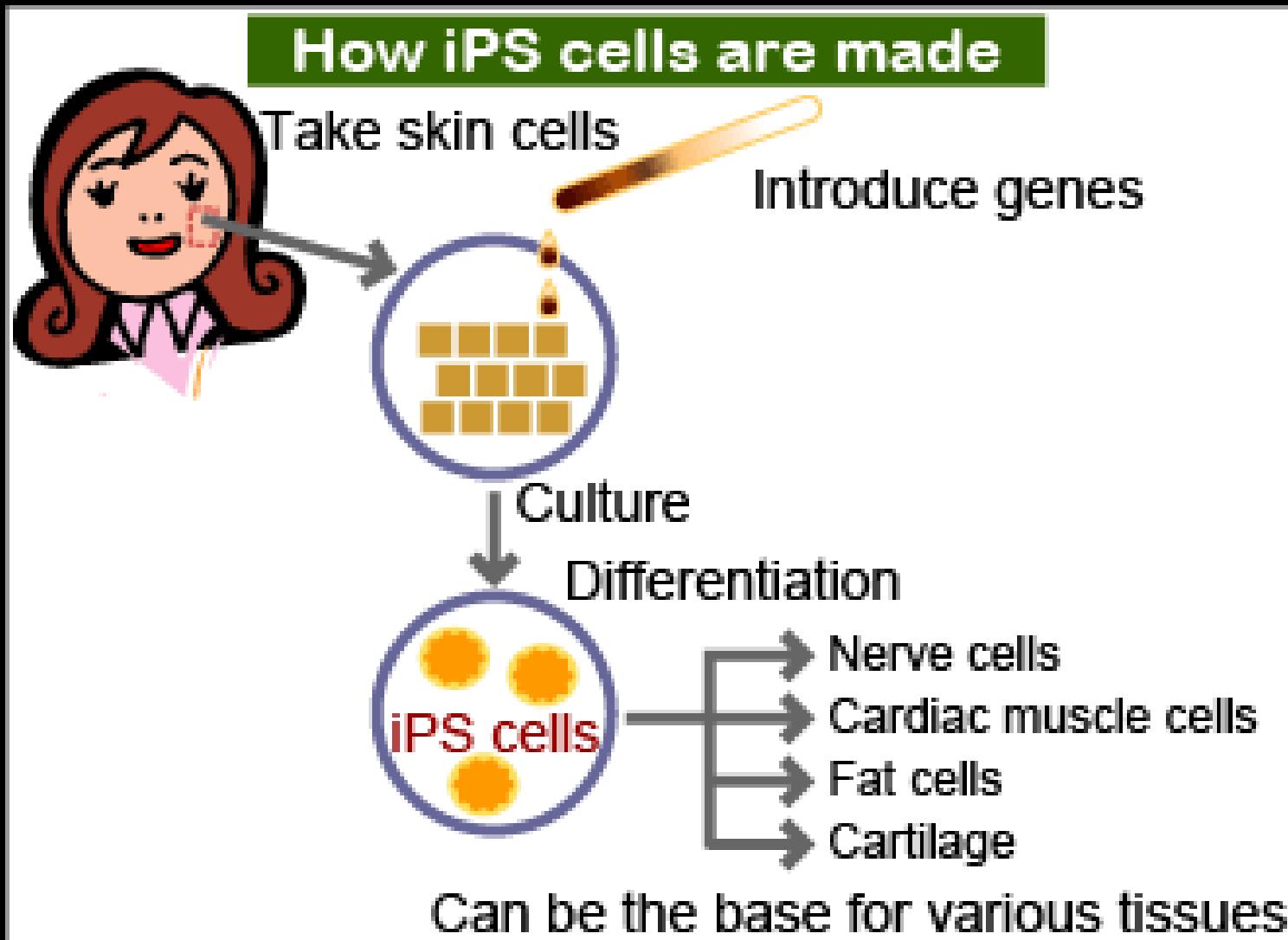
| Profile |  
Born on September 4, 1962. From Osaka Prefecture

| Interests | Jogging



## Prof Shinya Yamanaka, for iPSCs

# Induced Pluripotent Stem cells (iPS cells)





**Changing the future with stem cells**

# For decades, drug discovery has relied on animal models to investigate efficacy...Time for a Change....Science merges Engineering

**Genome**

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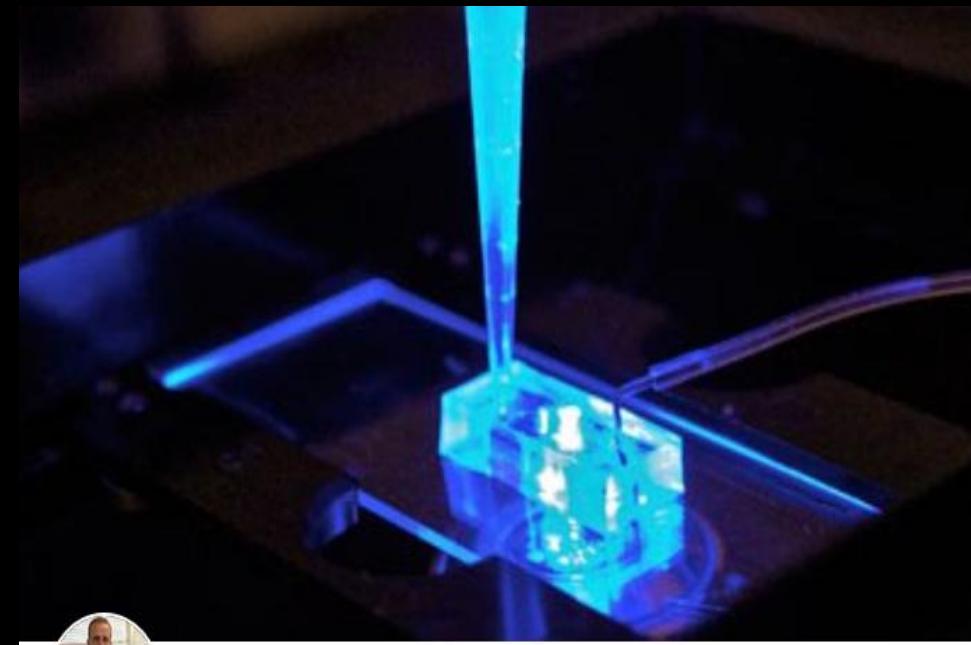
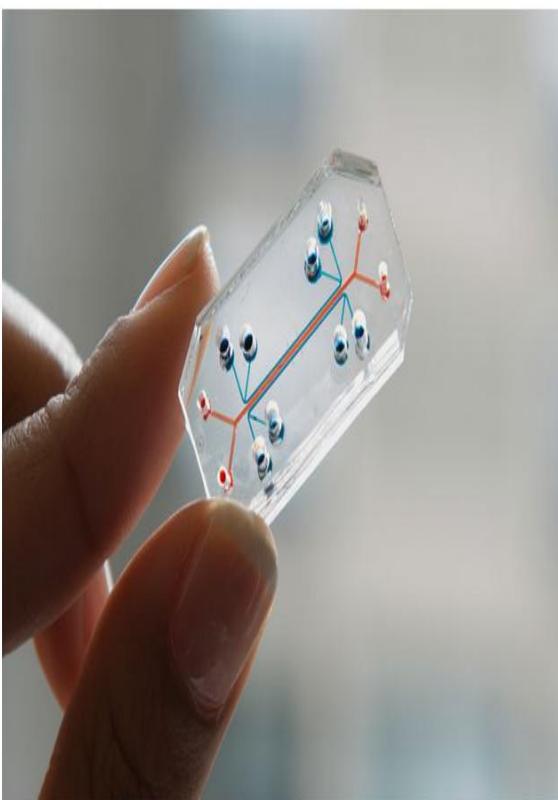
## The Small World of Organs On Chips

Teeny tiny biochips and mini organs are breaking big scientific barriers.

BY HEATHER MILLAR

f t in g+ e

April 5, 2016 | Print | 0 Comments



Nicholas Longworth  
Founder, Sports Performance Events & Head of Content/Digital Editor, Phacilitate

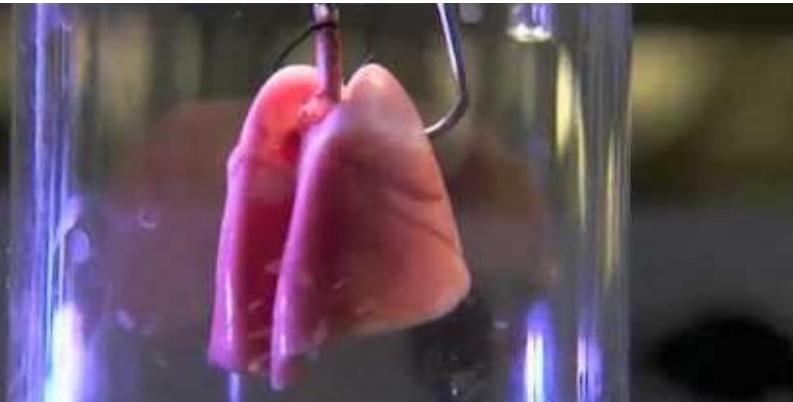
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### Lab on a Chip: Stem cells create 'mini-organs'

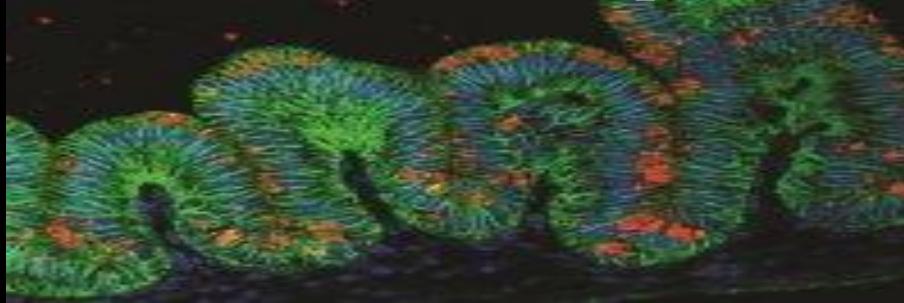
Mar 23, 2015 | 233 views | 1 Like | 0 Comments | in f t

Brought to you by Phacilitate Washington - 'Stem cells as discovery and research tools'.

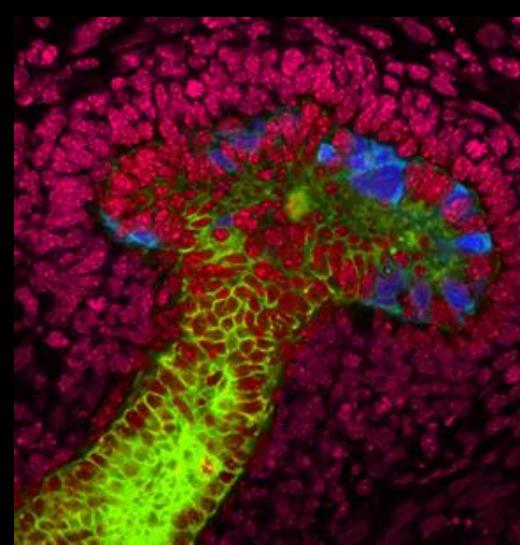
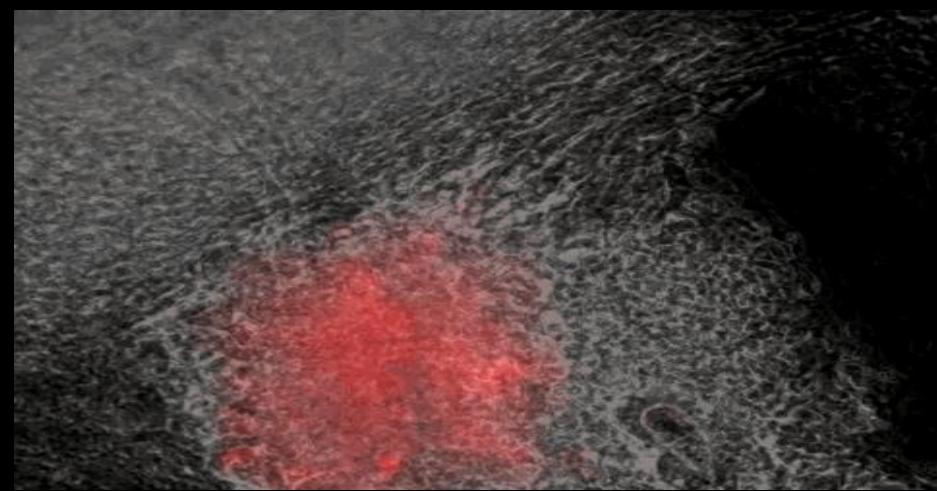
**2015- a team from the University of Cambridge created "mini-lungs"**



**2014 - Nature study on "mini-stomachs" Cincinnati Children's Hospital**



**2015-Bioengineers from Berkeley presents a network of pulsating cardiac muscles housed in 1 inch-long silicone**



**2013- 3D kidney structure - Salk Institute for Biological Studies**

# Stem cell therapy to treat diabetes

An experimental stem cell therapy designed to reverse the course of Type I diabetes allowed patients to go treatment-free for months and in one case, three years, a study released Tuesday said.

Thirteen of the 15 patients who took part in testing the therapy were able to quit the insulin injections that most diabetics depend on and remain insulin-free today, the researchers reported in the *Journal of the American Medical Association* (Jama).

One of the first patients to undergo the procedure has gone three years without using any supplemental synthetic insulin to regulate their blood sugar levels.

"This is the first therapy for Type I diabetes to result in drug-free treatment," said Richard Burt, chief of immunotherapy at Northwestern University's Feinberg School of Medicine in Chicago, and one of the senior authors of the research report.

While investigators continue to monitor patients' progress, the preliminary results raise the tantalising possibility that type I diabetes may

not be a life sentence, according to a prominent US diabetes researcher.

"This study by Voltarelli et al is the first of what likely will be many attempts at cellular therapy to interdict the Type I diabetes mellitus (DM) disease process," said Jay Skyler of the University of Miami.

"Research in this field is likely to explode in the next few years and should include randomised controlled trials as well as mechanistic studies. As these further studies confirm and build on the results of Voltarelli et al, the time may indeed be coming for starting to reverse and prevent Type 1 DM."

His comments appeared in an editorial accompanying the JAMA paper. Julio Voltarelli is the

first of the 15 patients to have been dispensed with

Brazilian researcher from the University of Sao Paulo in Ribeirao Preto, Brazil, who oversaw the trial.

Type I diabetes accounts for only five to 10% of all cases of the disease, but can result in serious complications including blindness, kidney failure, heart disease, and stroke.

The condition arises when the body's own immune system attacks and destroys the insulin-producing beta cells of the pancreas, causing a shortage in the hormone required to regulate blood sugar.

By the time most patients receive a clinical diagnosis, 60 to 80% of their beta cells have been wiped out.

The researchers in this trial hoped that if they intervened early

enough they could reprogram the body's immune system, allowing the small reservoir of beta cells left to regenerate.

To that end, they enrolled diabetics who had been diagnosed within the previous six weeks.

The researchers set out by harvesting stem cells from the volunteers.

The patients then underwent chemotherapy to wipe out their own immune systems, and were subsequently given transfusions of their own stem cells to rebuild their immune systems.

Fourteen of the 15, or 93%, were insulin-free for some period of time following the treatment.

Eleven of those dispensed with

supplemental insulin following treatment and have not had recourse to synthetic insulin since then. Periods of remission range from 36 months for the patient who had the therapy first to six months for more recent graduates of the trial.

Two other patients needed some supplemental insulin for 12 and 20 months after the procedure, but eventually both were able to wean themselves from the synthetic form of the hormone supplied in daily shots.

One patient went 12 months without shots, but relapsed a year after treatment after suffering a viral infection, and resumed daily insulin injections.

Another volunteer was eliminated from the study because of complications.

Further studies will be required to evaluate the safety and efficacy of this therapy, but the early signs are encouraging, in terms of the benefits and the low risk of side effects, which included one case of pneumonia and two cases of hormone dysfunction, the authors said.

- AFP

**TIME**

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How the Coming Revolution in  
**STEM CELLS**

Could Save Your Life

BY ALICE PARK



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## NEWS HEALTH

### Parkinson's stem cell 'breakthrough'



NEWS

## theSun

### Cord blood bank saves its first baby

SINGAPORE: Toddler Hoh Sin Jin has become the first to receive a transplant of umbilical cord blood to treat his leukaemia.

Last week, the Singapore Cord Blood Bank (SCBB) is the first of its kind in Singaporeans in need of a cord blood transplant, the hospital said. It aims for another 2,000 by next year.

The baby's condition had been critical and he was suffering from viral, bone and fungal infections, said Associate Prof. Tan Ah Moy, head of Paediatric Haematology and Oncology at KK Women's and Children's Hospital.

Blood taken from the umbilical cord is a source of immature cells that can develop into billions of different blood cells which can be used to replace diseased ones.

It took four months to find a

positive blood type match for the baby. The two-year-old Sin Jin is now back home.

Local hospital KK Women's and Children's Hospital said the Singapore Cord Blood Bank (SCBB) is the first of its kind in Singaporeans in need of a cord blood transplant, the hospital said. It aims for another 2,000 by next year.

Its cost - \$850,000 (RM469,000) - includes the transplant alone costs between \$80,000 (RM40,000) and \$150,000 (RM75,000). A government subsidy of about 50% of the cost is available to families that can turn to charitable foundations for help.

These include KKJ Health Foundation, the McDonald Fund and Children's Cancer Society. - oga



# Umbilical Cord Blood Banking



# Do You Have... Heart Failure?



is screening for eligible patients with these  
cardiovascular conditions for

# STEM CELL DEPOT

PARTS DEPT.

YA' GOT  
A FEMUR  
FOR A '57  
CAUCASIAN?

LAWRENCE '01