



Stem Cells: Introduction and Prospects in Medicine

Part II

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Bioscience in the 21st Century
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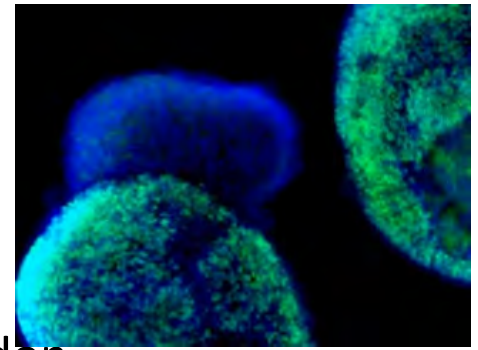
Overview

- **Setting the stage for the discussion:** historical perspective and prospects in regenerative medicine
- **Stem Cell Basics:**
 - What are stem cells?
 - Where do stem cells come from?
- **Stem Cell Therapy Challenges**
- **Selected Stem Cell Advance in the News:**
Prospects for treating Type 1 Diabetes

Stem Cell Research in the News!

Selected News about Stem Cells

- “Scientists Find Way to Track Stem Cells in Brain”
(*Science*, November 2007)
- “Stem Cells Restore Memory in Mice”
(*Journal of Neuroscience*, October 2007)
- “Researchers Isolate Adult Stem Cells for First Time in Tendon”
(*Nature Medicine*, September 2007)
- “Stem Cells From Testes Produce Wide Range of Tissue Types”
(*Nature*, September 2007)
- “Scientists Turn Human Skin Cells into Stem Cells”
(*Science*; *Cell*, November 2007)
- “First Neurons Created from ALS Patient’s Skin Cells”
(*Science*, July 2008 [online])
- “Identification of small molecules for human hepatocyte expansion and iPS differentiation”
(*Nature Chemical Biology*, June 2013)
- “Photoreceptor precursors derived from three-dimensional embryonic stem cell cultures integrate and mature within adult degenerate retina”
(*Nature Biotechnology*, July 2013)
- “Generation of functional human pancreatic beta cells in vitro”
(*Cell*, October 2014)



Treatment Strategies for Diabetes

Refer to Dr. Beth Careyva's discussion for Strategies and Future Prospects

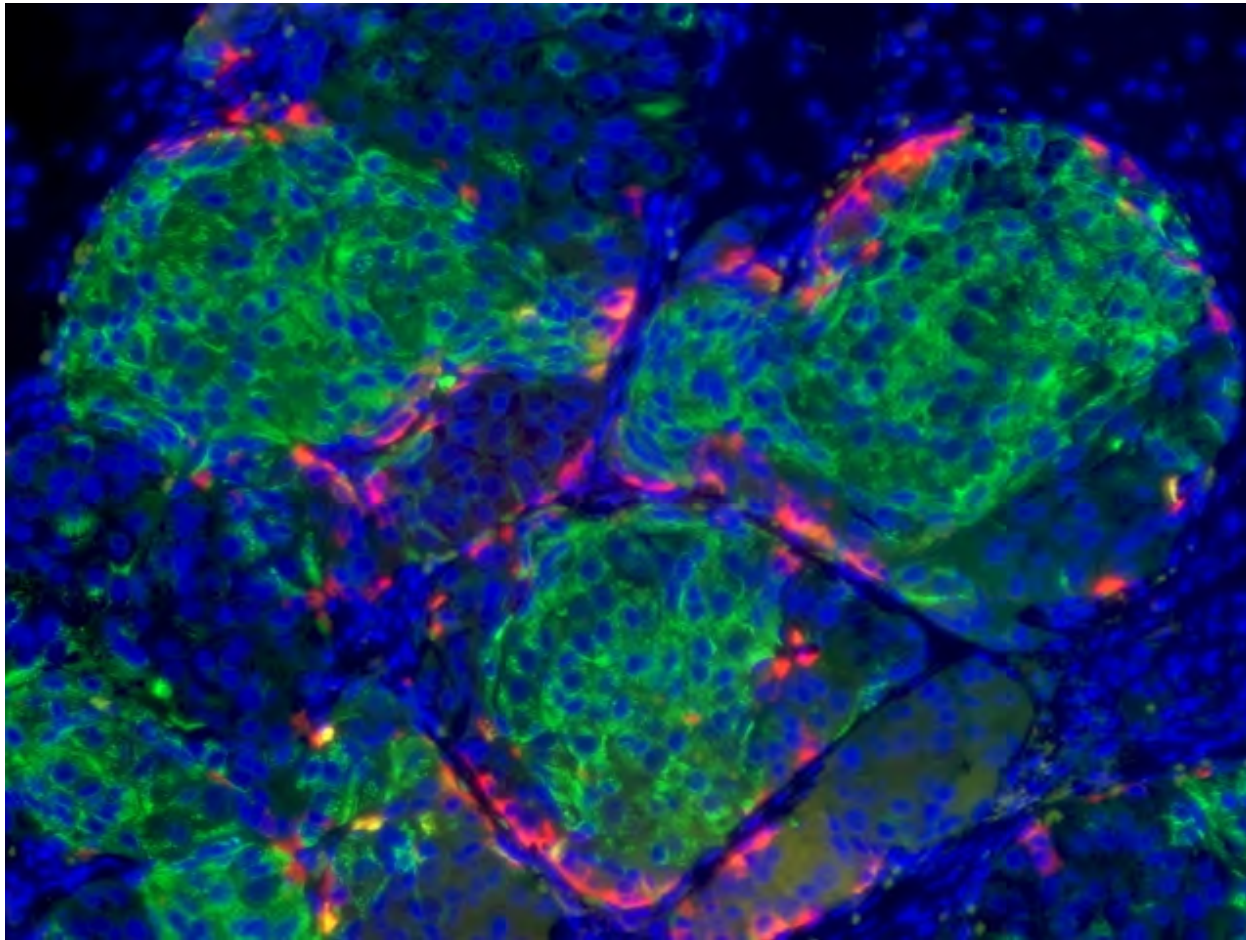
Current experimental treatments only with limited availability:

- Cell transplantation using cells from cadavers
- Requires use of strong immunosuppressive drugs to avoid rejection of transplanted cells
- Not widely available to large number of patients

How might stem cell therapy play a role in treating diabetes?

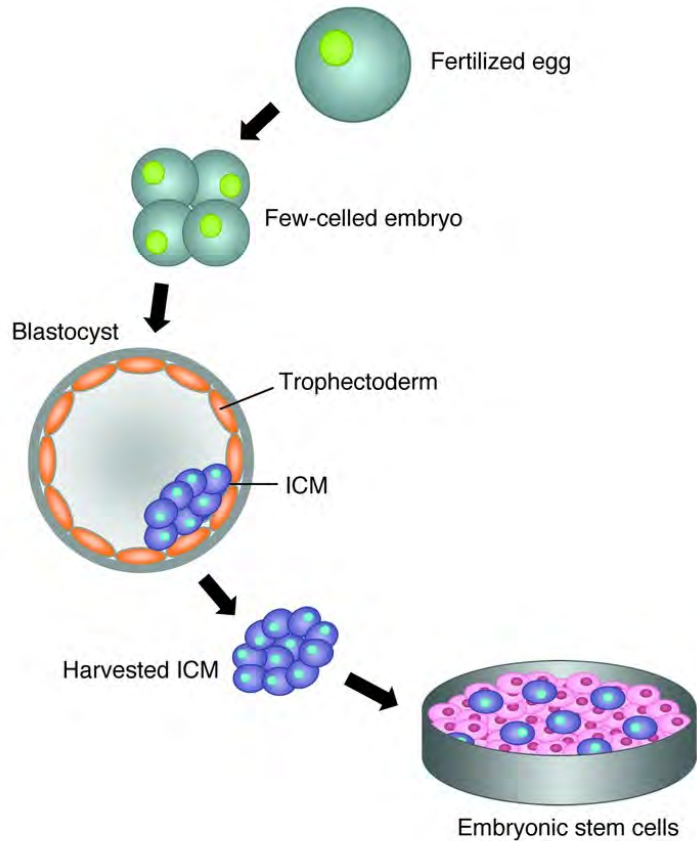
“From stem cells to billions of human insulin-producing cells”

Pagliuca, F., Millman, J. and Gürtler, M, et. al. Generation of functional human pancreatic beta cells *in vitro*. *Cell*. October 9, 2014.

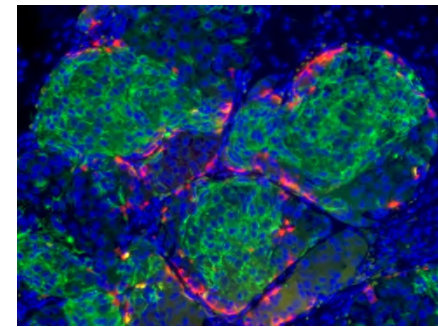


<http://hsci.harvard.edu/news/stem-cells-billions-human-insulin-producing-cells>

A complex recipe is required to transform hESCs into β cells

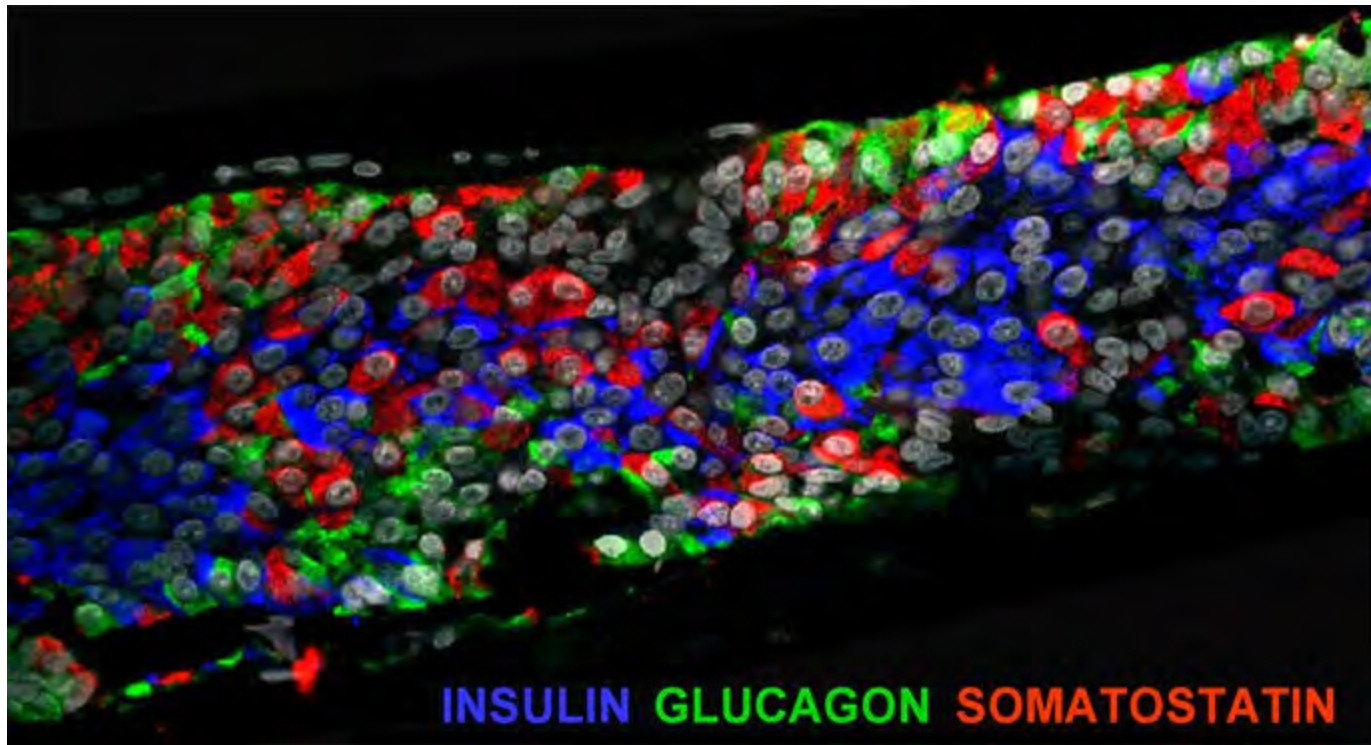


5 different growth media + 11 molecular factors (proteins and sugars) added in precise combinations over 35 days; can harvest 200 million cells in 500ml flask



β cells

Phase I/II clinical trials started in September 2014 by biotech company ViaCyte and UC San Diego to study the safety and efficacy of a new investigational drug called VC-01 in patients with Type 1 diabetes



Specially encapsulated stem cell-derived cells will be implanted under the skin of patients where they will differentiate into pancreatic β cells that produce insulin.

Stem cell source for experiments:

human embryonic stem cells or iPSCs

What are some of the immediate challenges that must be faced if insulin-producing cells derived from hESCs or iPSCs are transplanted into a wide range of patients?

IDEAS for DISCUSSION

Solving complex problems in life science using interdisciplinary approaches

How will transplanted cells be protected from attack by the immune system?

Melton (a molecular developmental biologist) is collaborating with chemical engineering faculty at MIT to develop an implantation device to protect cells from attack.

Preliminary tests show that cells in mice are still functional after several months when protected by the implantation device

Summary:

- **Stem cell therapies offer regenerative prospects for numerous human diseases**
- **Stem cells are capable of renewal and differentiation.**
- **Stem cells are derived from numerous sources and have different potency capacities.**
- **Adult stem cells (ASCs) have been detected in numerous tissues.**
- **Induced pluripotent stem (iPS) cells offer great potential.**
- **Considerable debate surrounds the use of embryonic stem cells. Adult stem cells may offer similar prospects for therapy as do as ESCs, yet a complete understanding of stem cell applications will require a basic understanding of differentiation and renewal mechanisms in ASCs and ESCs as well.**

Additional resources: <http://stemcells.nih.gov/info/basics/>

Ode to a Stem Cell, Part II

by VCW

There once was stem cell stuck **in the 'hood'**
Dividing endlessly, but only wishing he could
Become something else, a skin cell, a hair cell, or some other type
But for weeks he sulked and uttered this gripe
“Why am I not needed?” to his friends he would say
Isn't there a **call for a specialist** somewhere today?
Well, if you really want to leave to get a new start,
You must **change your tune**, for surely there is an art
To consider **what signals you hear** and **choices you make**.
Divide once more for the **special journey** you take.
Dare to be different, as you **differentiate!**

