Blue Skies

Future Innovations in Healthcare

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Stem Cells – Types, Flavours & Sources

Human Developmental Continuum

- Single-cell Embryo
- 3-day Embryo
- 5-7 day Embryo
- 4-week Embryo
- 6-week Embryo

Embryonic Stem (ES) cells
Embryonic Germ (EG) cells (primordial germ cells)
Fetal Tissue Stem cells
Cord Blood Stem cells
Placental Stem cells

- Pluripotent
- Multipotent
- Multipotent
- Multipotent
- Multipotent
Inner Cell Mass
Cardiomyocyte production

H7 hESC

Expansion

5 x 10^9 hES cells

Differentiation

Media 1
Media 2
Growth Factors
Feed
Cardiomyocytes
Stem cells

- Stroke
- Traumatic brain injury
- Learning defects
- Alzheimer's disease
- Parkinson's disease
- Baldness
- Blindness
- Deafness
- Amyotrophic lateral sclerosis
- Wound healing
- Bone marrow transplantation (currently established)
- Spinal cord injury
- Osteoarthritis
- Myocardial infarction
- Muscular dystrophy
- Diabetes
- Multiple sites:
T-cell therapy
The next generation in cancer treatment

Cell Collection → Cell Separation → T-cell Selection, Activation and Expansion → Genetic modification → Cell Harvest & Concentration → Cell Infusion into Patient → Cell Collection
Cell-based immunotherapy technology

In Girl’s Last Hope, Altered Immune Cells Beat Leukemia
By DENISE GRADY
PHILIPSBURG, Pa.—Emma Whitehead has been bounding around the house lately, practicing somersaults and rugby-style tumbles that make her parents wince.

Penn Med's Carl June discusses breakthrough cancer research
Carl June talks to the DP about his team's new T-cell immunotherapy treatment
By DINA MOROZ - February 25, 2013, 6:17 pm

Chimeric Antigen Receptor–Modified T Cells in Chronic Lymphoid Leukemia
David L. Porter, M.D., Bruce L. Levine, Ph.D., Michael Kalos, Ph.D., Adam Bagg, M.D., and Carl H. June, M.D.
Current Trends/Debates in Human Healthcare

- Personalized “omics” & healthcare data bases
- Wearable clinical devices – Internet of the Patient
- Advent of synthetic intelligence in diagnostics/therapy allocation – Deep Mind/Watson
- Gene editing & gene “driver” technology
- Pharmacological enhancement
- Rise of robots in healthcare applications
- Synthetic organisms & novel protein design
- Relaxation of regulations in stem cell therapies
- Genetic engineering of human embryos
- Clinical use of “artificial” gametes
Emergent “Digital Age” Technologies in Healthcare

Integration of technology & biology

Implantable Electronic-Biologic Interfaces

Microbiomic Diagnostics

In vivo Dx - regenerative medicine

Neural Prosthetics and Brain Implants

3D bio-printing
3D bio-printing

Benefits
- Complex Integrated Geometries
- Internal “parts” to “whole organ”
- New thinking about design & clinical utility
- Broad range of biological opportunities

Rapidly expanding capability
- Flexibility – Volume of 1
- 3D Design to part fast
- Polymers, Metals, Bio-materials, Circuits Boards, Cell printing ...

Emerging industrial process
The evolution of biotherapy

The generations of biotherapy

Fabricated tissue and organ
Replace/regenerate tissue, replace organs

Cell therapy
Regenerate tissue / activate patient’s biology
The next major growth area

Monoclonal antibodies
Highly specific targeting of diseased cells
’08 Market ~$40B, Growth ~20%

Replacement therapy
Treat manifestation of disease by replacing deficient molecules
’09 Market ~$60B, Growth ~5%
Drivers for organ and tissue beyond 1:1 donation

Donor organ demand outstrips supply

Areas considered – number of procedures:
- “Essential to life” organ transplant data
- Tissue grafts

Data from [optn.transplant.hrsa.gov](http://optn.transplant.hrsa.gov) and OPTN/SRTR Annual Report.

** Data include deceased and living donors.

Graph from [http://www.organdonor.gov/about/data.html](http://www.organdonor.gov/about/data.html)
How to design a tissue

Our models are analyzed as networks at arbitrary resolution, enabling fractal tessellation of defined organs (lymph nodes, liver etc.)
UCSF team wins $26 million grant to build a brain implant
Nanorobotic Surgery – Future of Medicine