Title: Molly Shoichet: Engineering Change in Medicine

Date: Dec 07, 2016 07:00 PM

URL: http://pirsa.org/16120004

Abstract: Imagine going beyond treating the symptoms of disease and instead stopping it and reversing it. This is the promise of regenerative medicine.

In her Perimeter Institute public lecture, Prof. Molly Shoichet will tell three compelling stories that are relevant to cancer, blindness and stroke. In each story, the underlying innovation in chemistry, engineering, and biology will be highlighted with the opportunities that lay ahead.

To make it personal, Shoichetâ€™s lab has figured out how to grow cells in an environment that mimics that of the native environment. Now she has the opportunity to grow a patientâ€™s cancer cells in the lab and figure out which drugs will be most effective for that individual.

In blindness, the cells at the back of the eye often die. We can slow the progression of disease but we cannot stop it because there is no way to replace those cells. With a newly engineered biomaterial, Shoichetâ€™s lab can now transplant cells to the back of the eye and achieve some functional repair.

The holy grail of regenerative medicine is stimulation of the stem cells resident in us. The challenge is to figure out how to stimulate those cells to promote repair. Using a drug-infused â€œband-aidâ€• applied directly on the brain, Shoichetâ€™s team achieved tissue repair.

These three stories underline the opportunity of collaborative, multi-disciplinary research. It is exciting to think what we will discover as this research continues to unfold.

TheShoichetLab

University of Toronto

Engineering Change in Medicine

Molly S. Shoichet, PhD, FRSC, O Ont

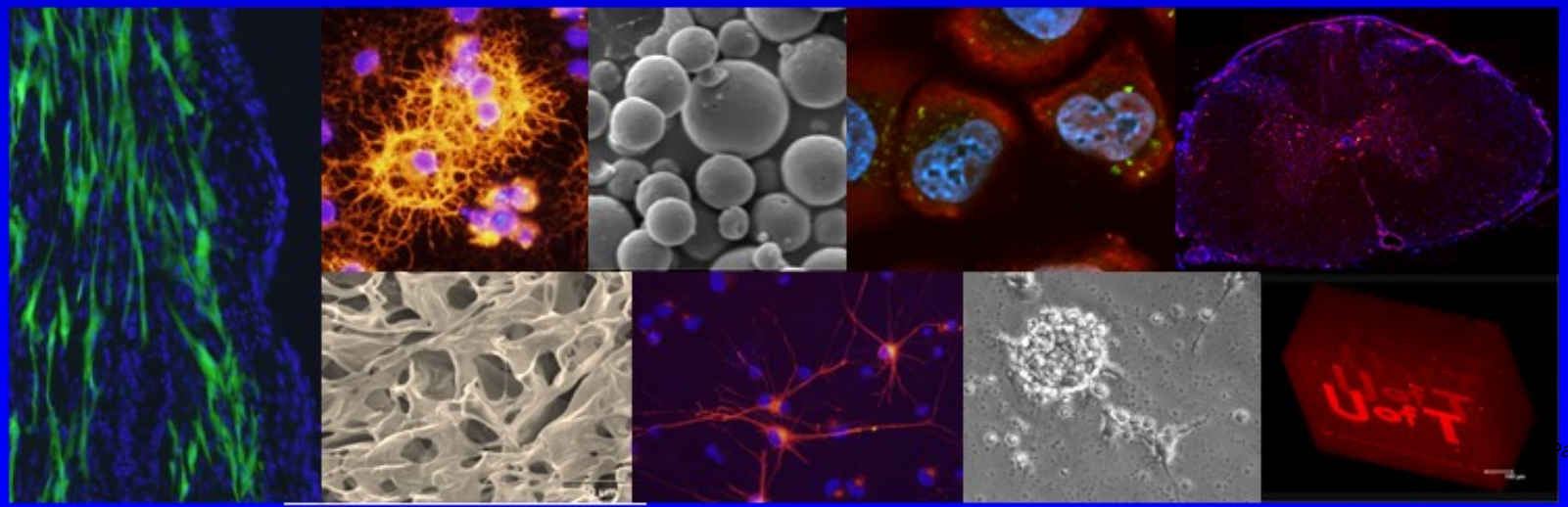
University Professor, University of Toronto

Canada Research Chair, Tissue Engineering

Chemical Engineering & Applied Chemistry,

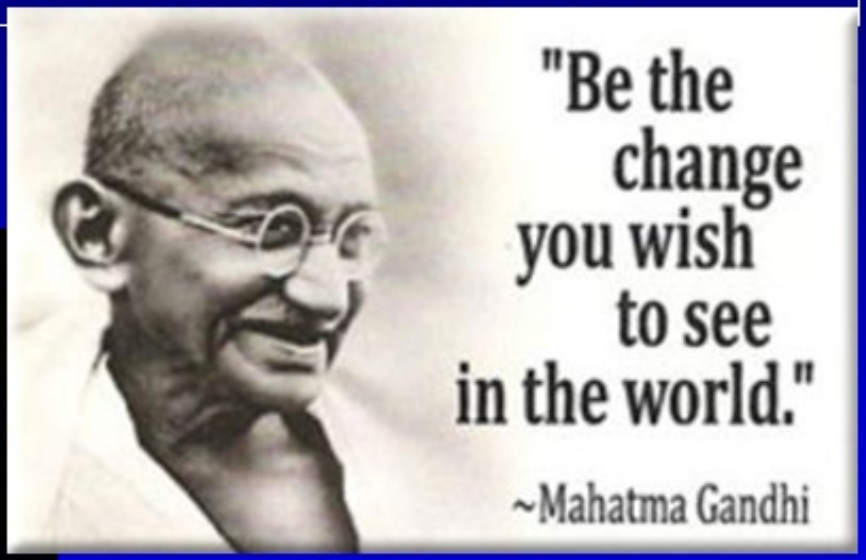
Chemistry, Biomaterials & Biomedical Engineering

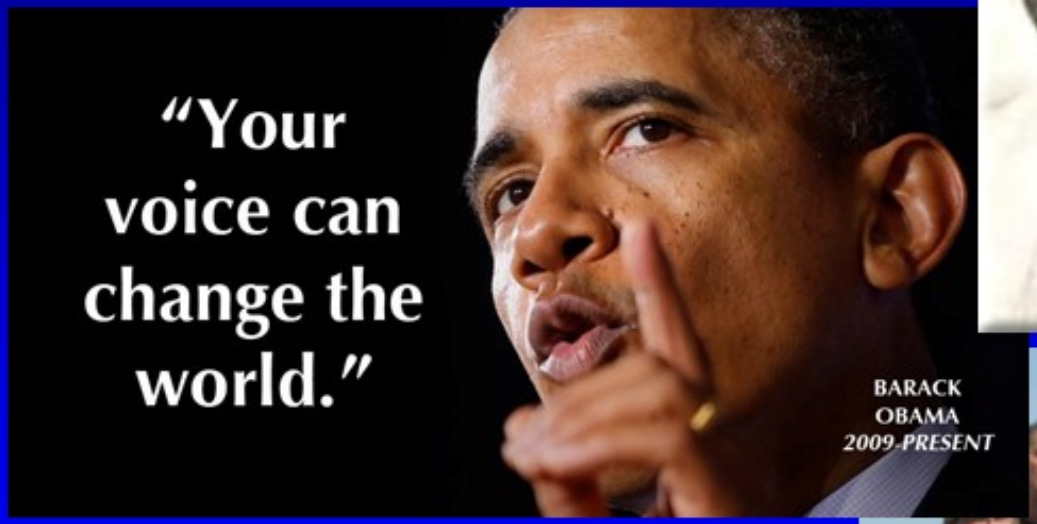
Donnelly Centre, McEwen Centre



Isn't it time for a change?

LandEscape, Richard Shoichet





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Research2Reality

today's research, tomorrow's reality

co-founders:
Molly Shoichet & Mike MacMillan

Social media campaign

- Website: research2reality.com

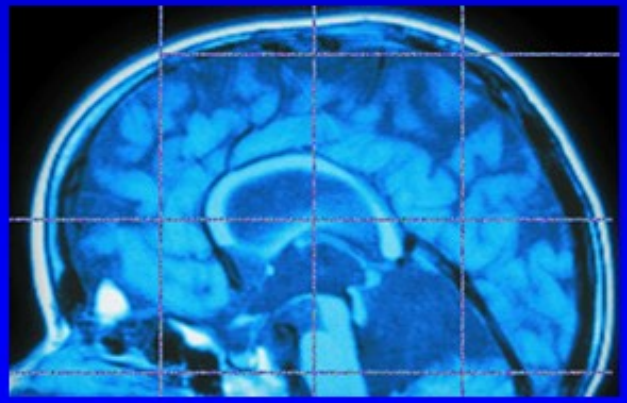
Partners

- Top Universities across Canada, CIFAR
- Ontario Government
- Discovery & Discovery Science

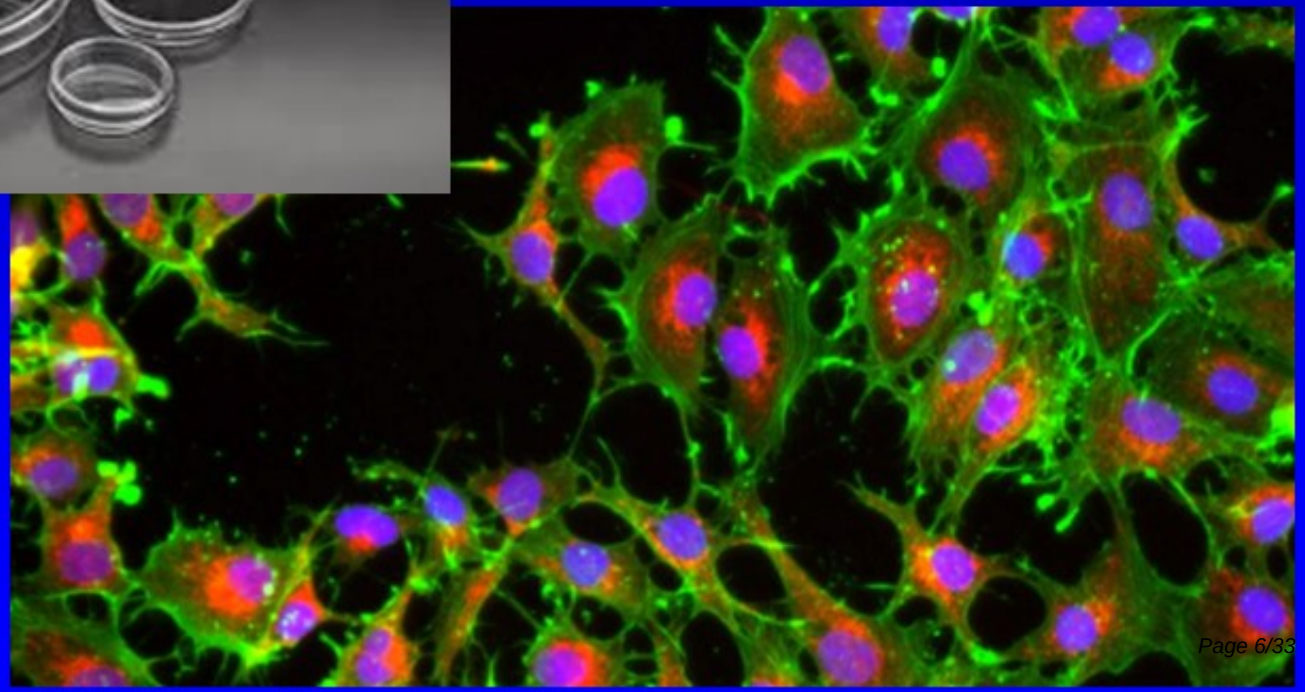
Change in Medicine

- Personalized Medicine

- Regenerative Medicine

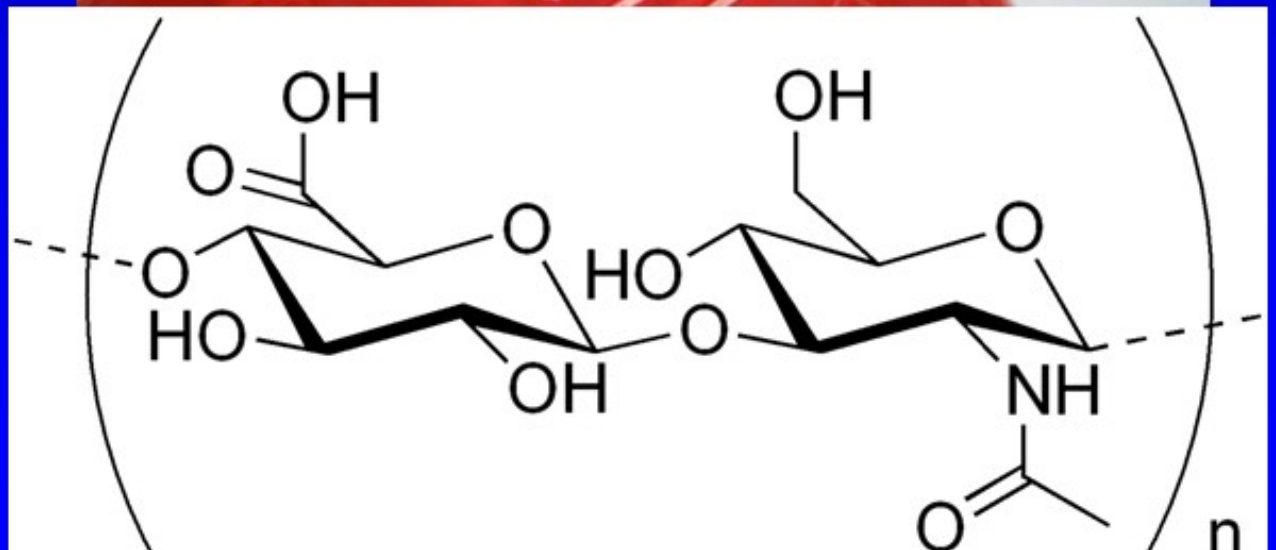


Conventional 2-D Cell Culture

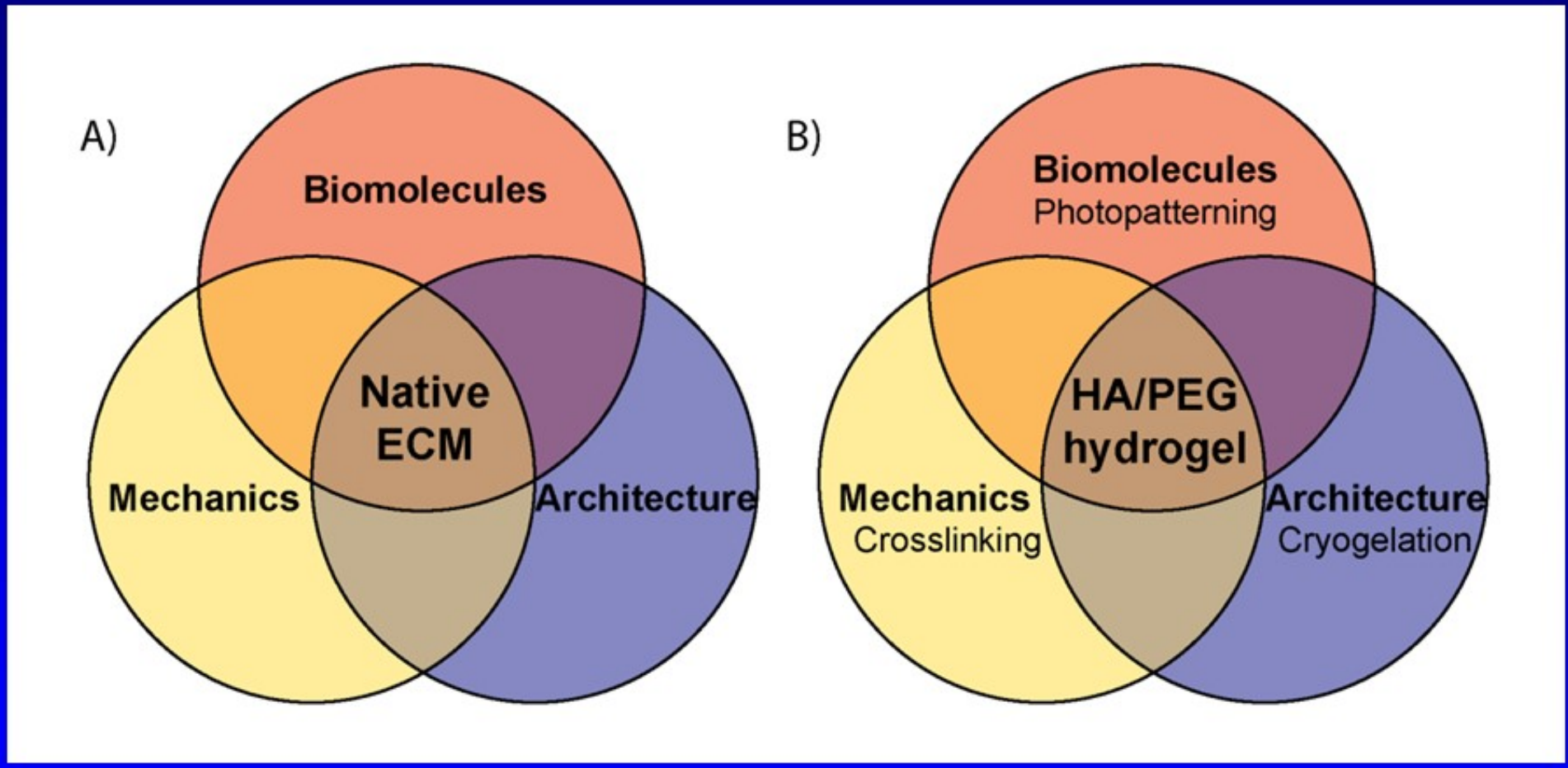


GE Healthcare Life Sciences

Hydrogels: water-swollen materials



Biomimetic Hydrogels



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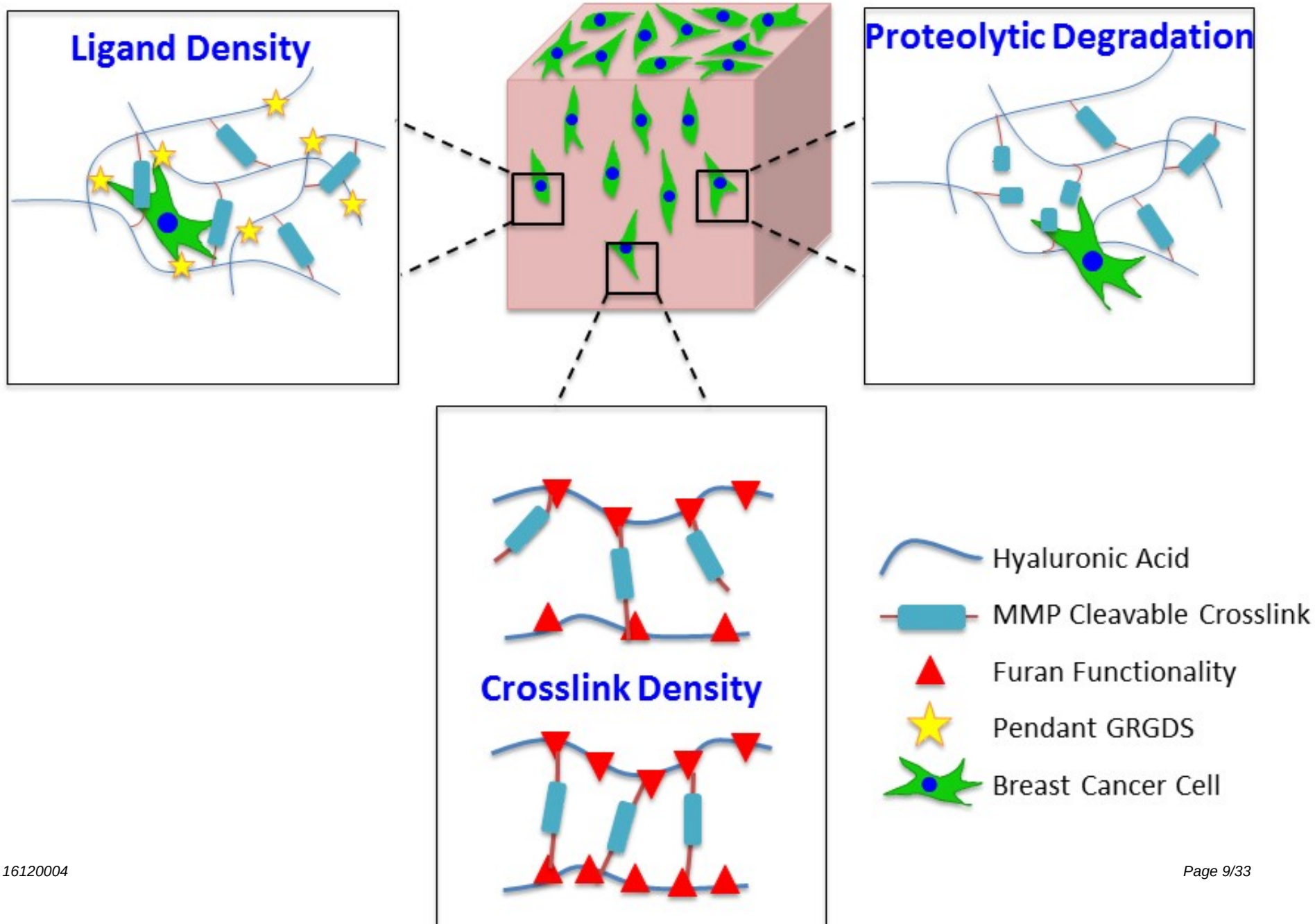
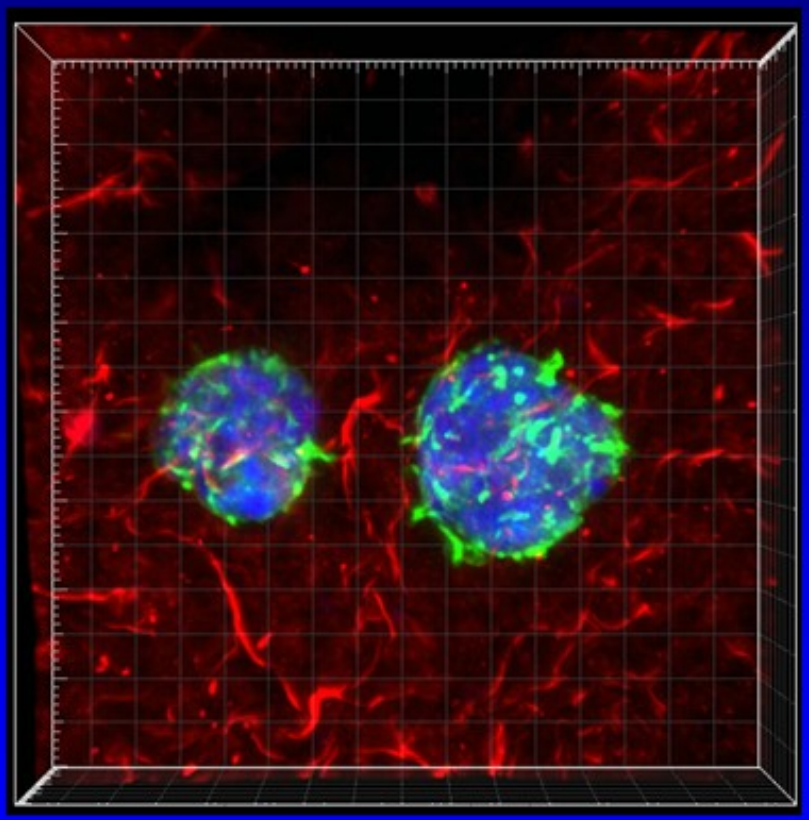
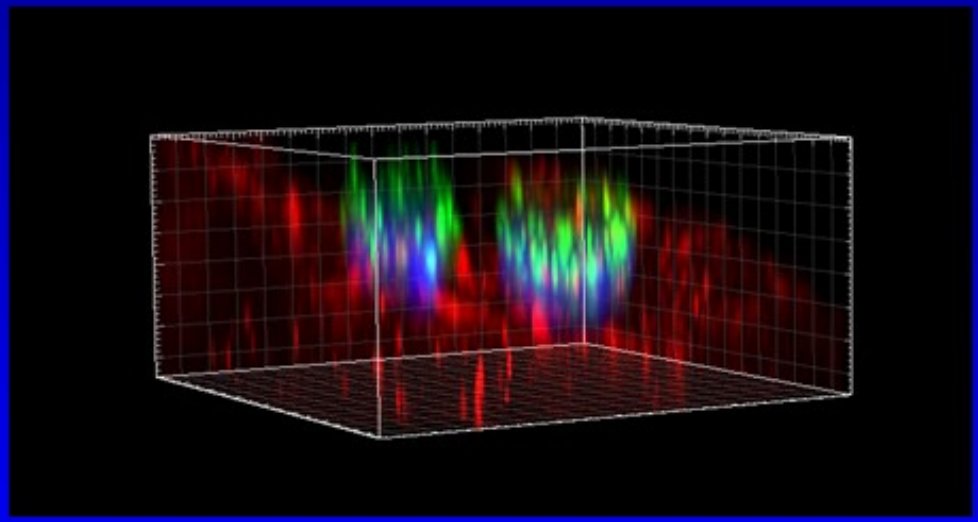
Hydrogel Microenvironment

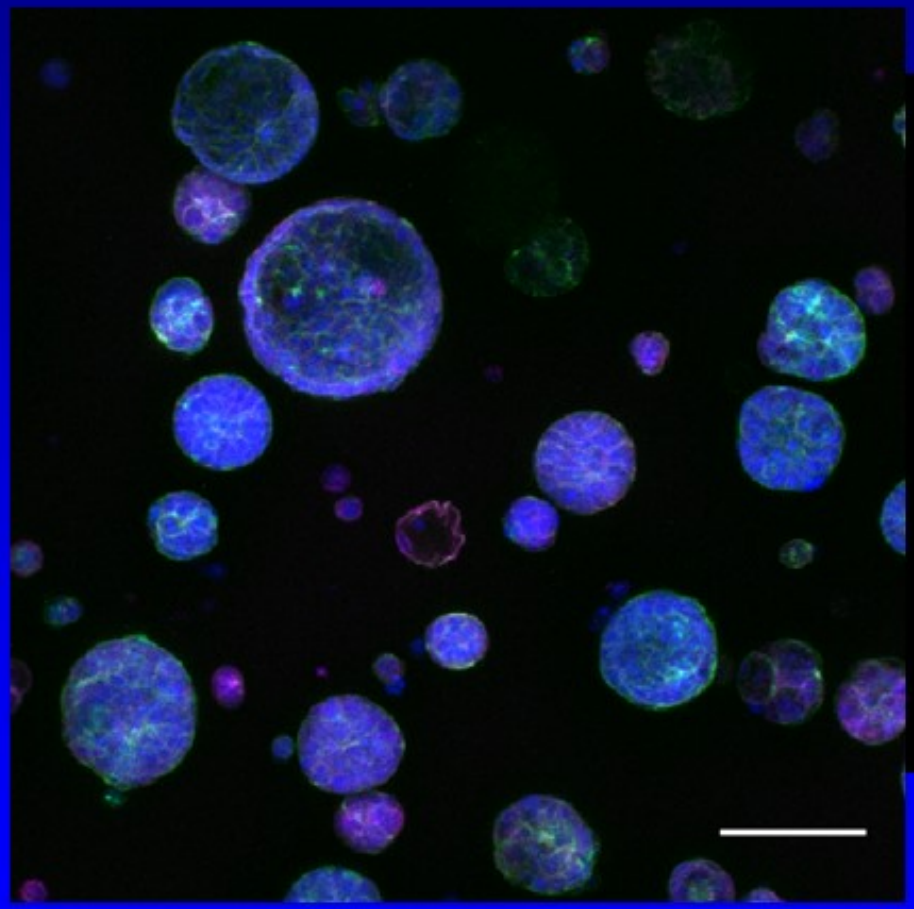


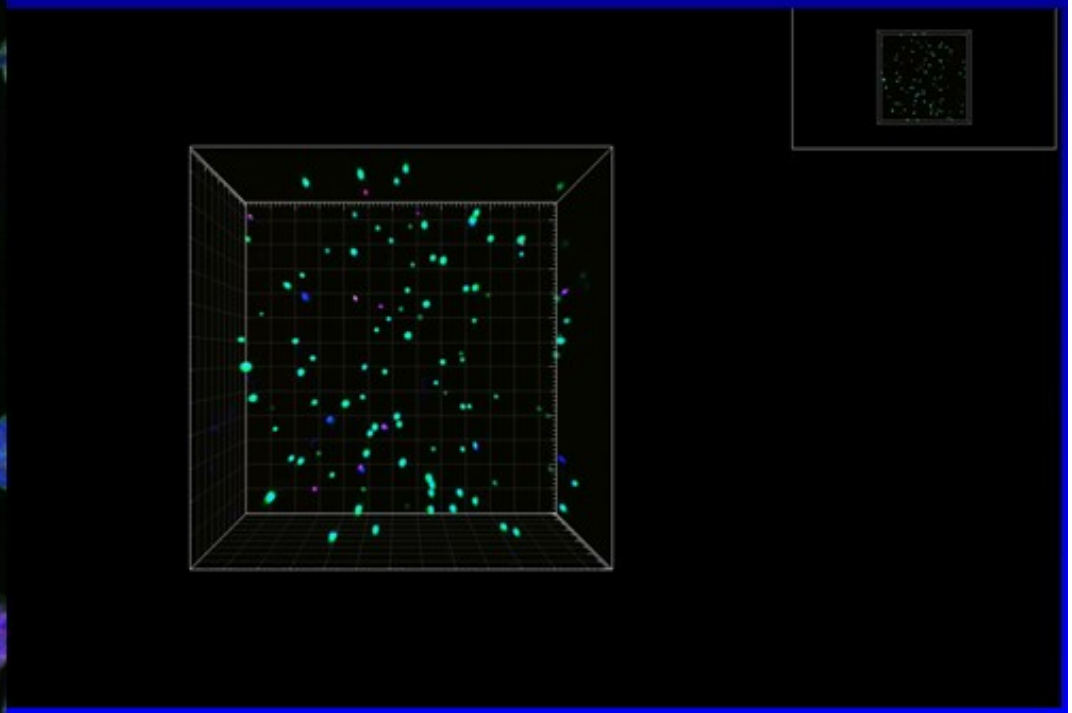
Breast Cancer Cells in 3D





Breast Cancer Cells in 3D

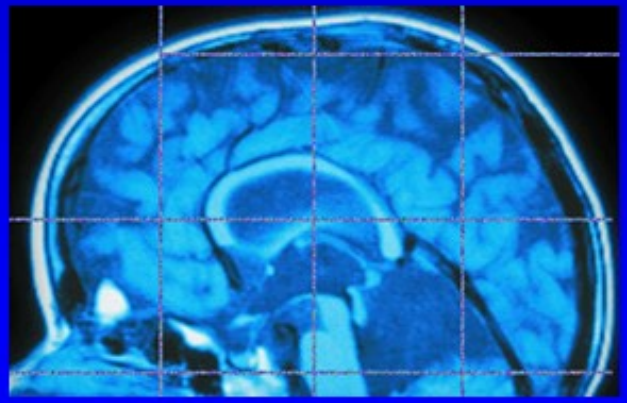




Change in Medicine

- Personalized Medicine

- Regenerative Medicine



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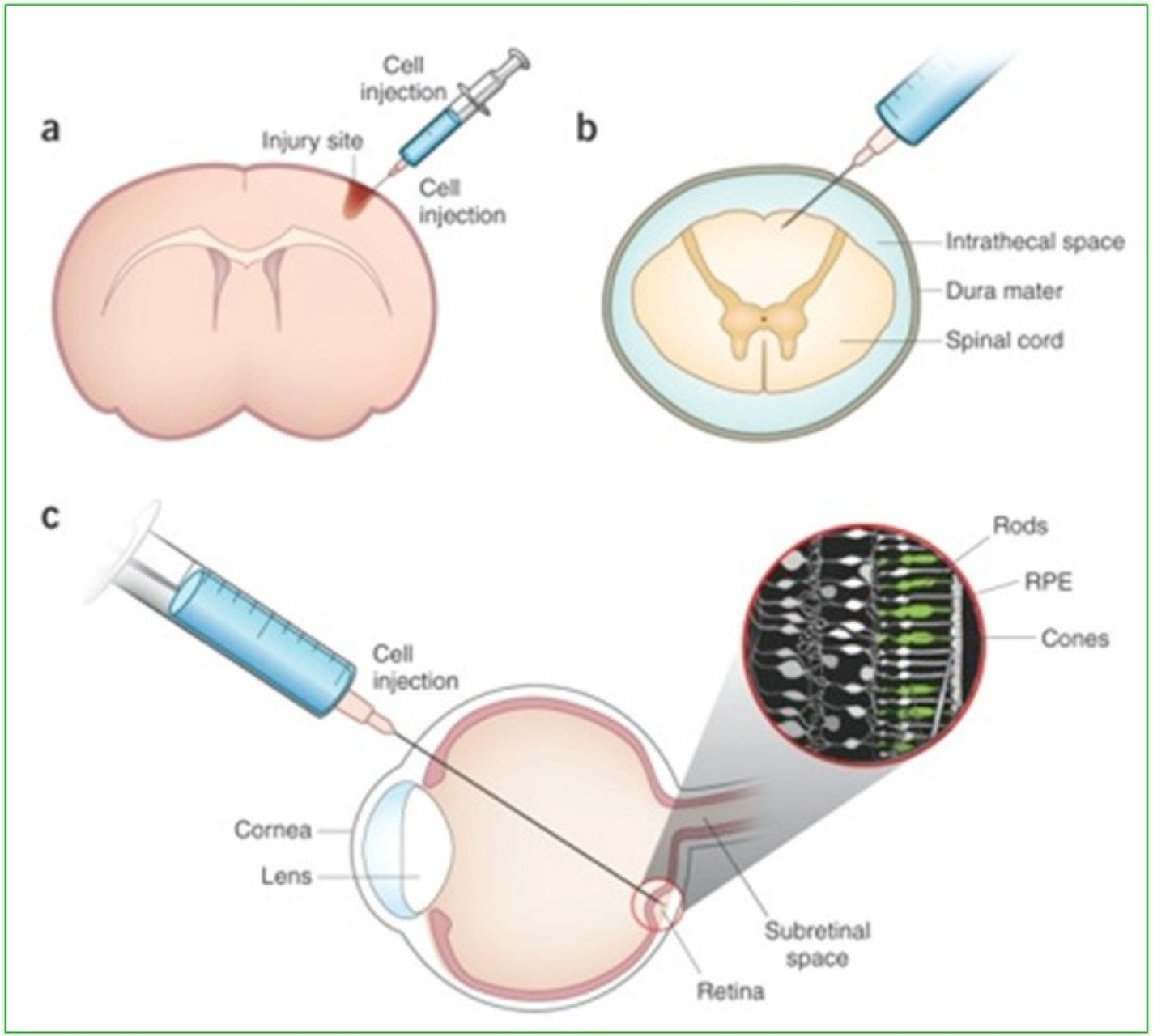
Injectable hydrogels

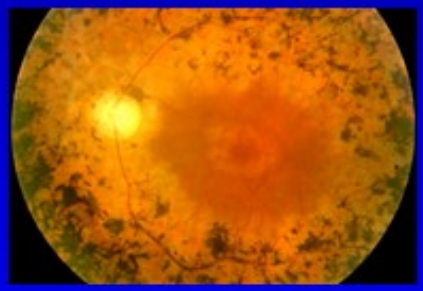


Tam, R.Y.; Fuehrmann, T.; Mitrousis, N.; Shoichet, M.S. "Regenerative Therapies for Central Nervous

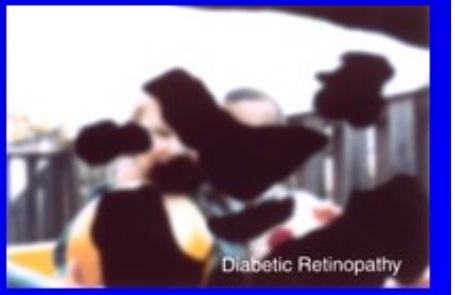
Leading causes of vision loss: retina degeneration

Age-related macular degeneration

Retinitis Pigmentosa



Diabetic Retinopathy



No definitive regenerative treatment

Pharmacologics only supportive

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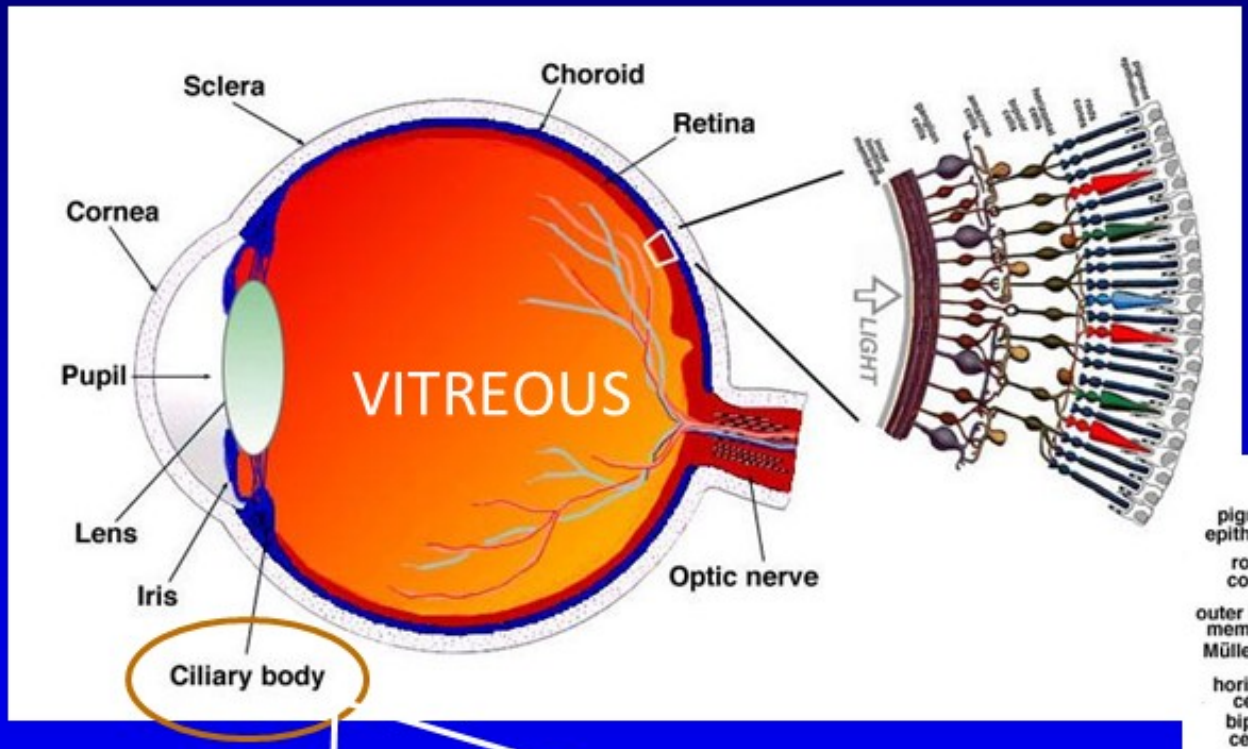
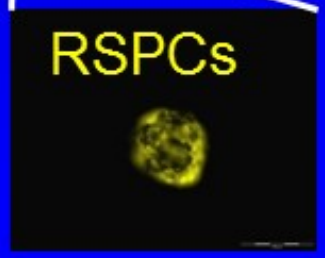
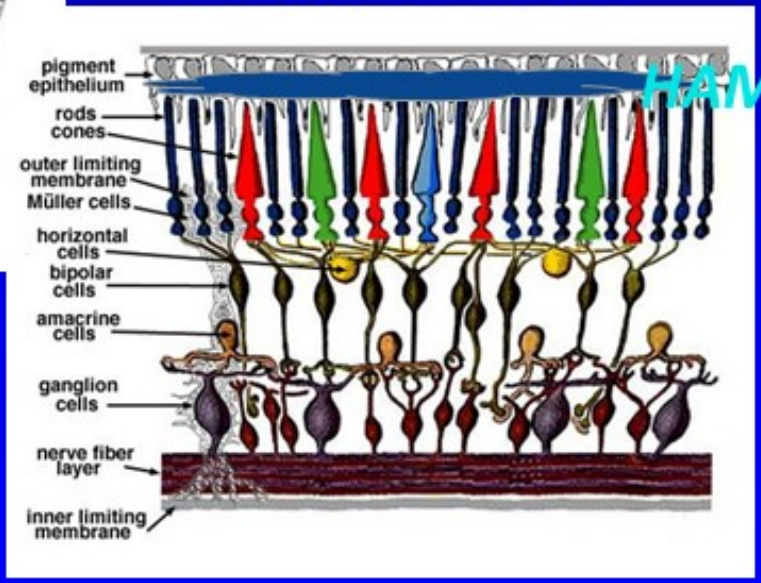
Vision Repair: Cell Transplantation in HAMC





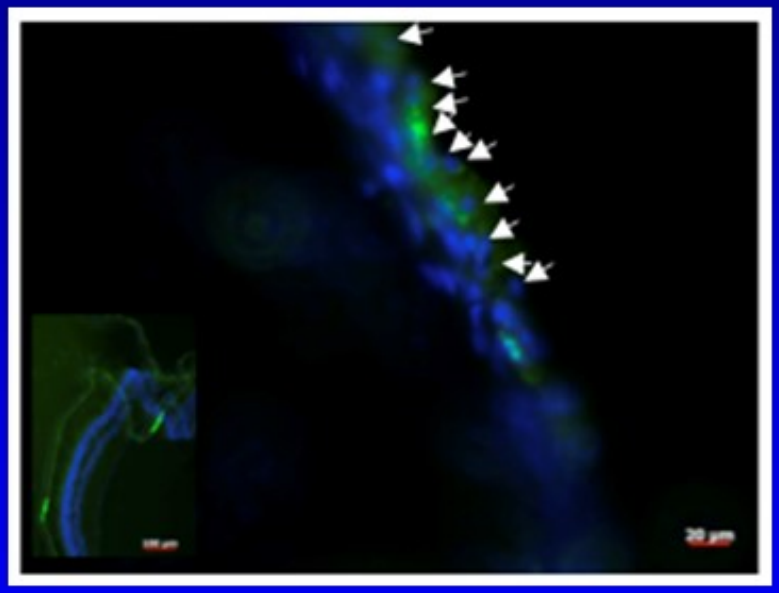
OUTSIDE OF EYE



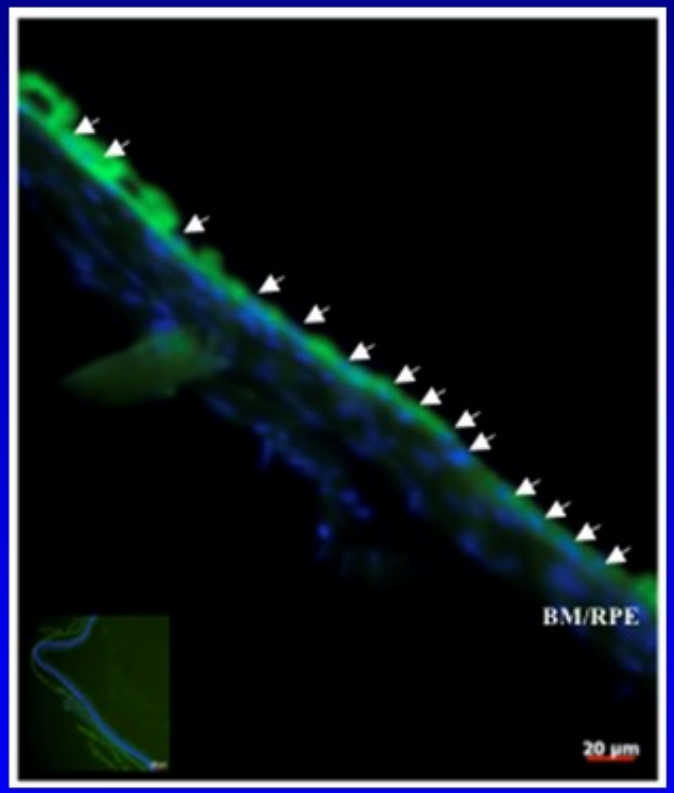
VITREOUS

Derek van der Kooy, Univ. Toronto

Injectable biomaterial enhances cell survival and distribution required for regeneration



Saline Injection of Cells



Biomaterial Injection of Cells

Ballios, Cooke, van der Kooy, Shoichet, Biomaterials 2010

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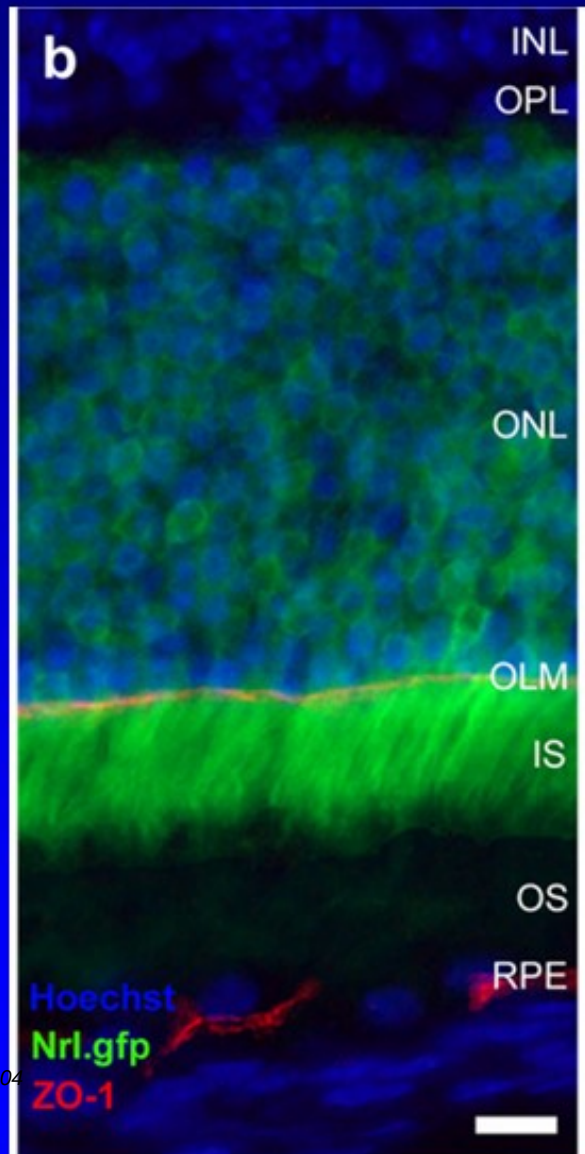
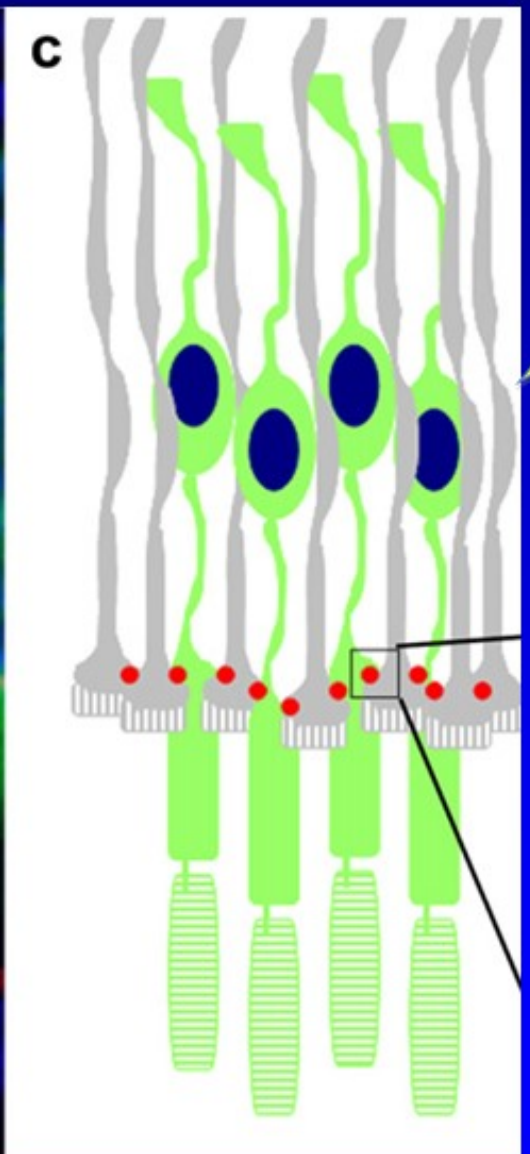
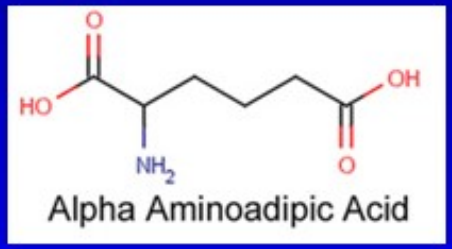
Addressing integration directly





AAA



Alpha Aminoadipic Acid

West *et al.* Exp. Eye Res. 2008

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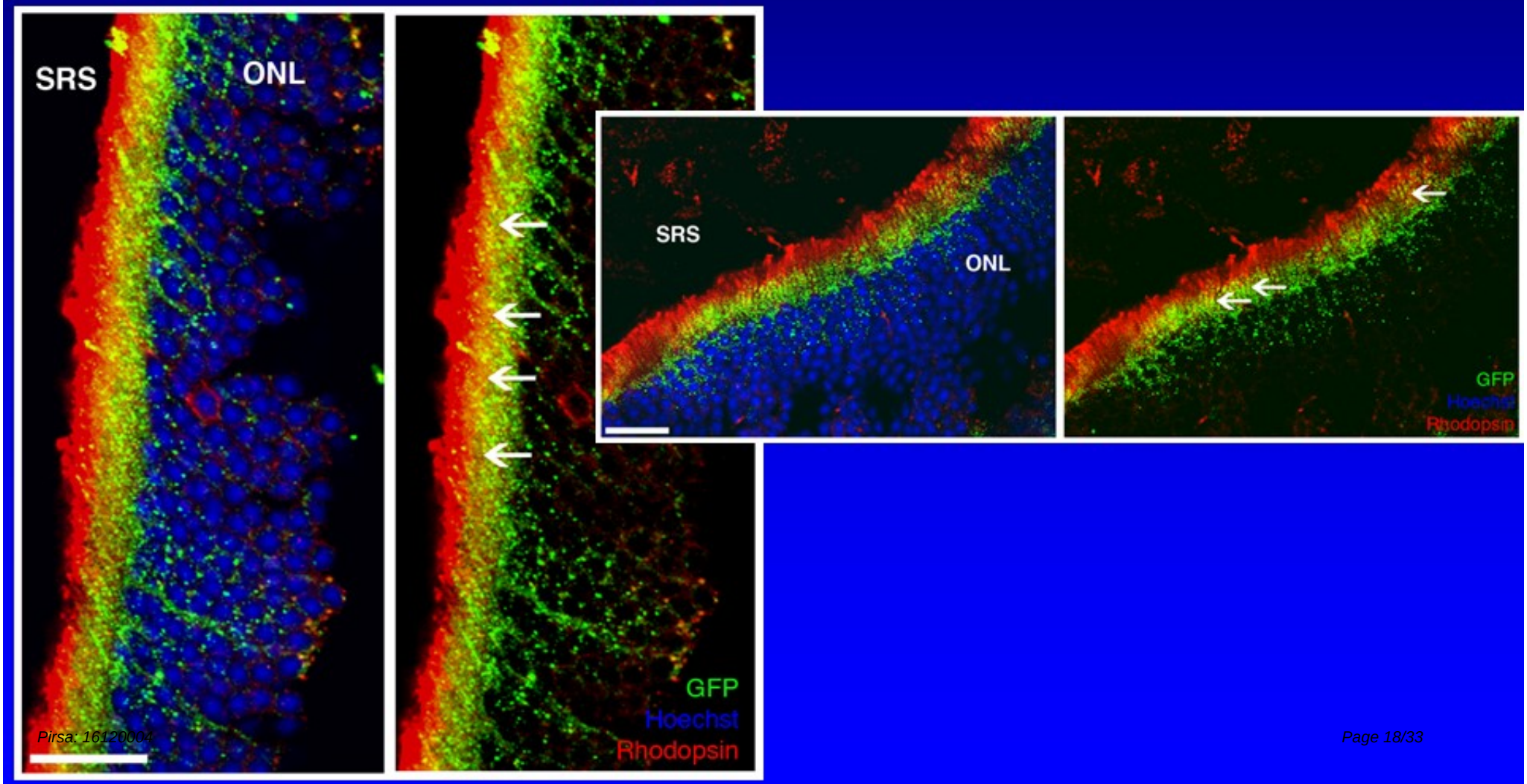
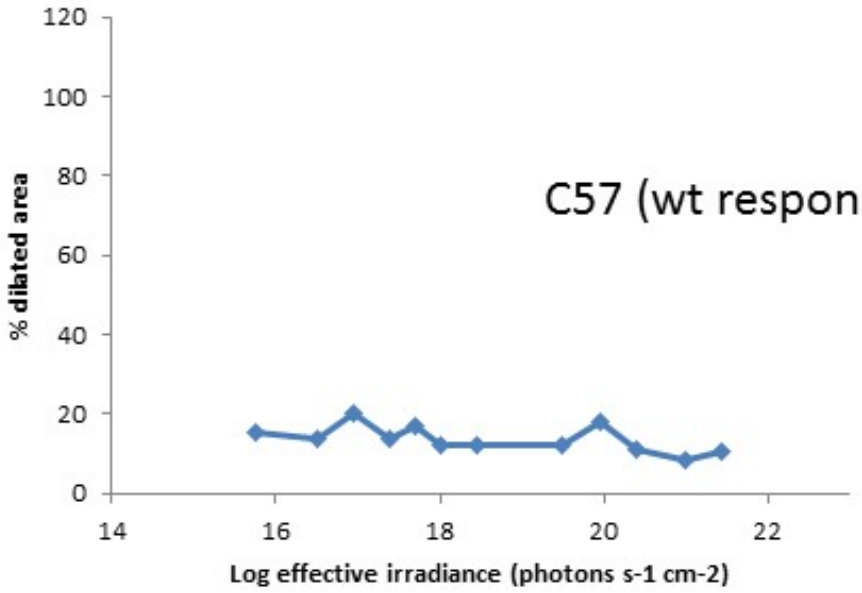
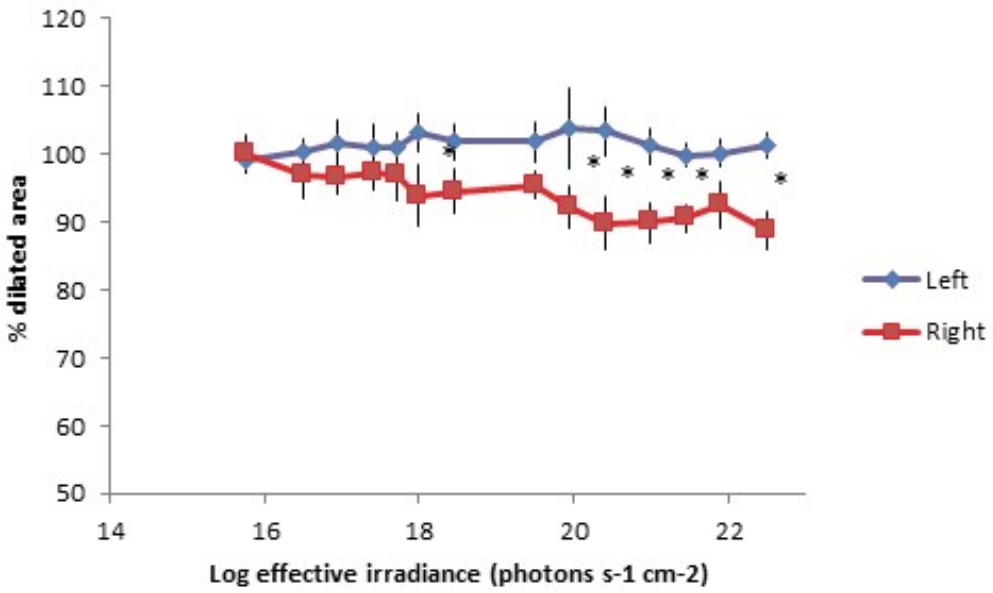
Retinal Stem Cell-derived Rods Integrate into Adult Retina



TKO mice show functional recovery of pupillary light response after injection of RSC-derived rod photoreceptors

Subretinal injection into adult TKO animals (Gnat1-/-;CngA3-/-;Opn4-/-)





Left eye = vehicle injection (HAMC+AAA)

Right eye = HAMC+AAA+RSC-derived rods

Is greater cell survival possible with an enhanced delivery vehicle?

Tam et al. J. Mater. Chem 2012

Change in Medicine

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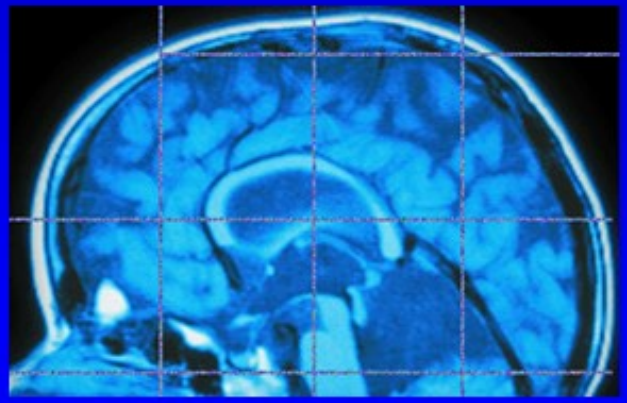
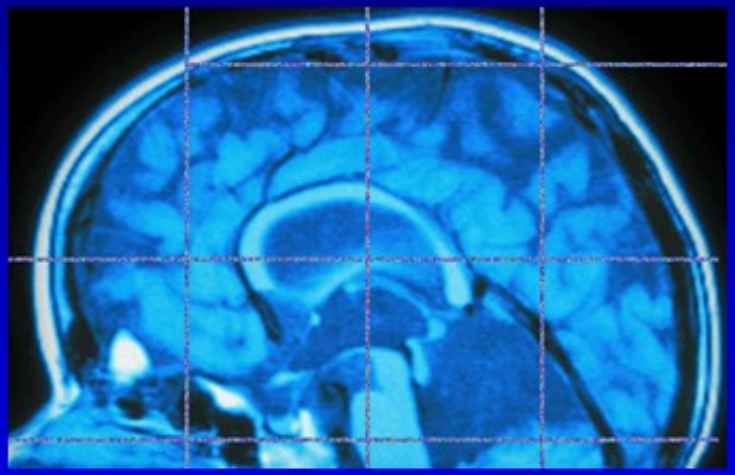


Stroke Problem:
Traumatic loss of function and tissue



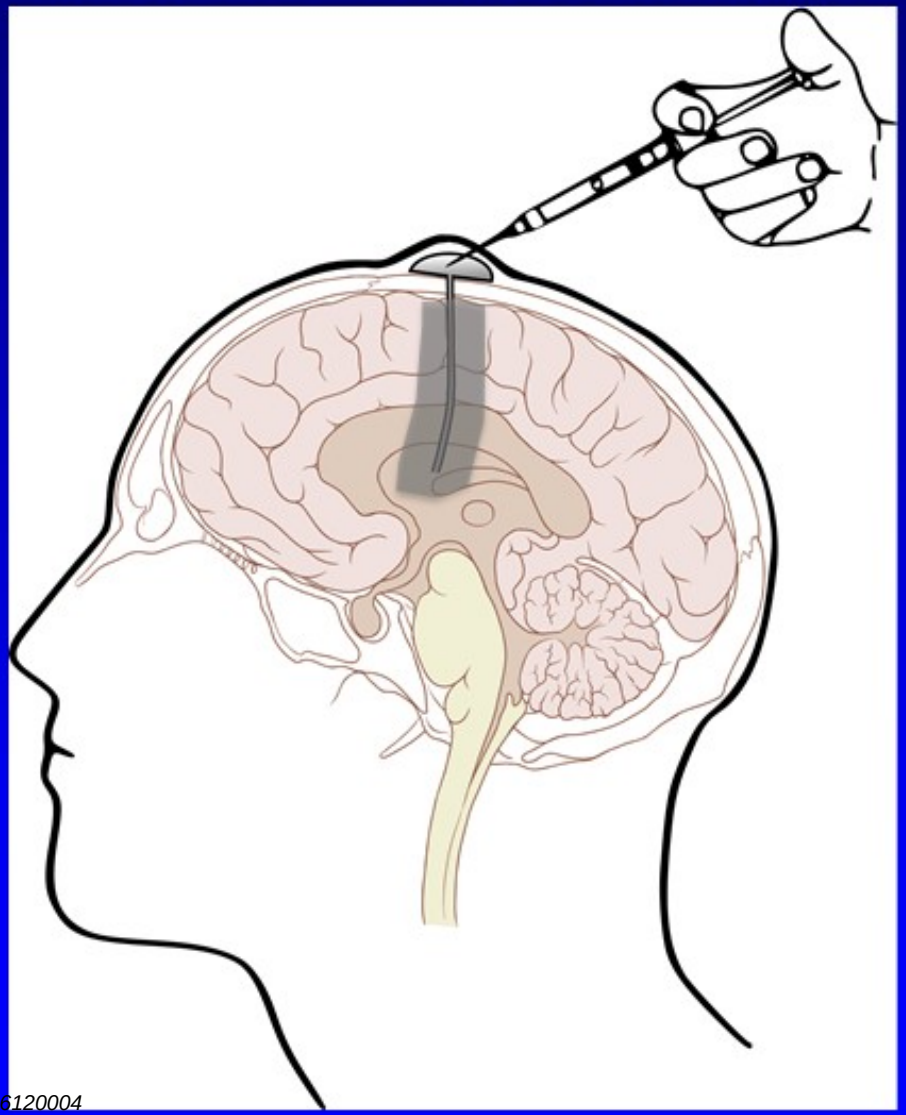
Stroke: rapidly developing loss of brain function(s) due to an interruption in the blood supply to the brain: ischemic or hemorrhagic

- affected area of the brain is unable to function
- inability to move limb(s) on 1 side of body
- inability to understand or formulate speech
- inability to see one side of the visual field.

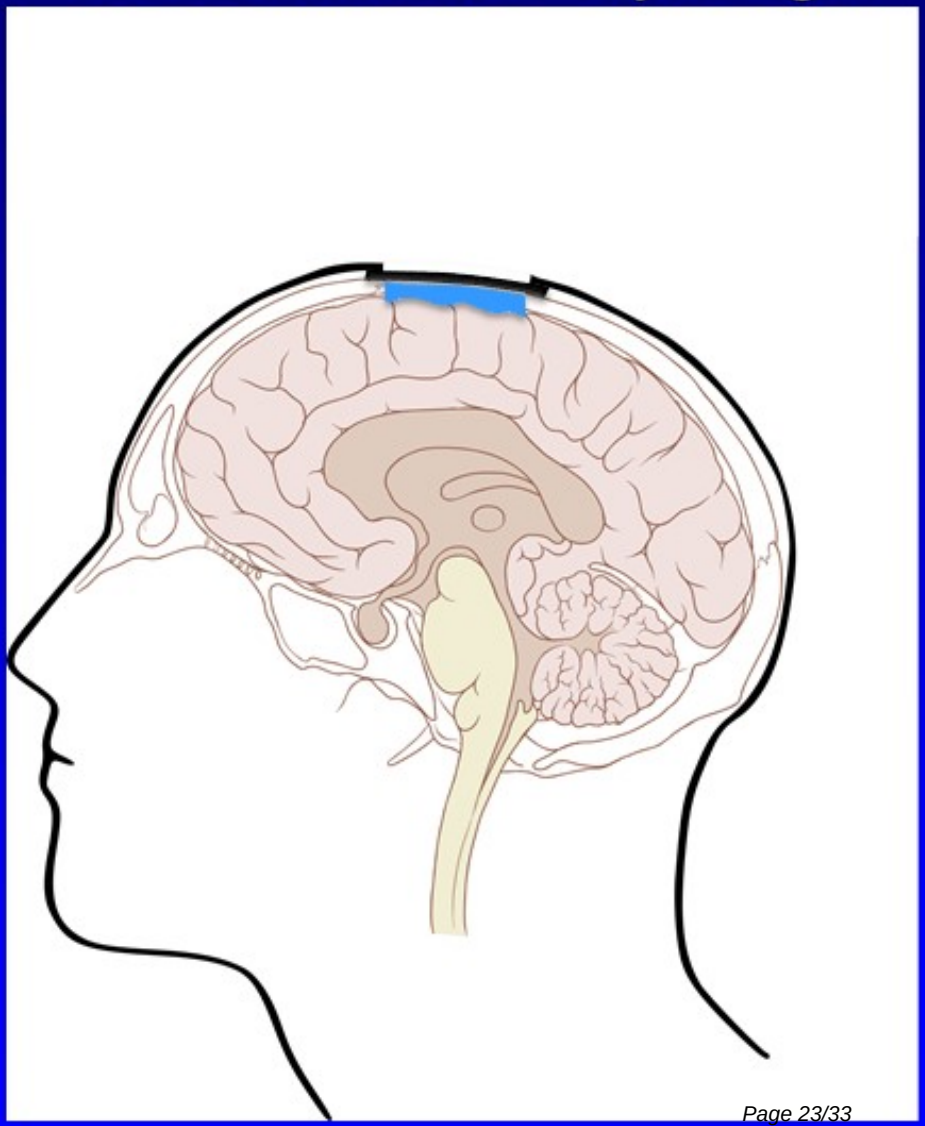
Blood vessel blockage → O_2 and nutrient reduction → Apoptosis and Necrosis → Tissue damage → Behavioural deficit

3rd leading cause of death in America

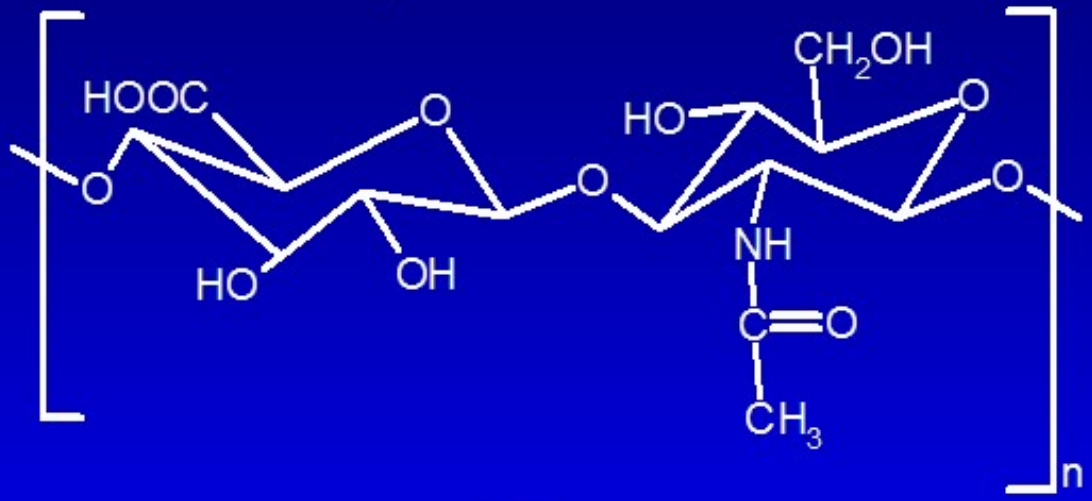
Invasive Catheter/Pump



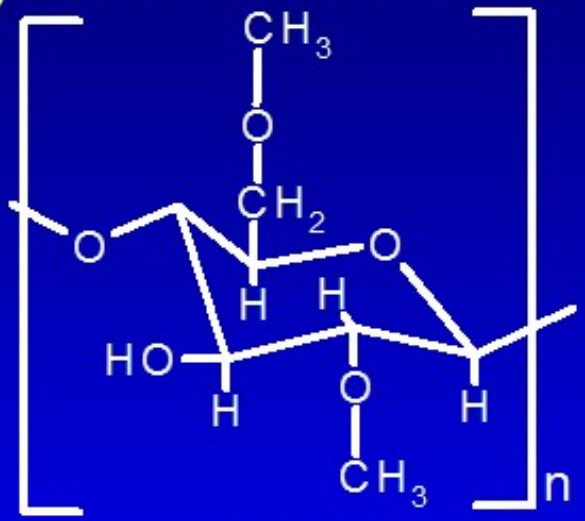
Less Invasive Hydrogel



Biomaterials that Promote Healing
Hyaluronan / Methylcellulose



HA
Shear Thinning



MC
Thermal Gelling

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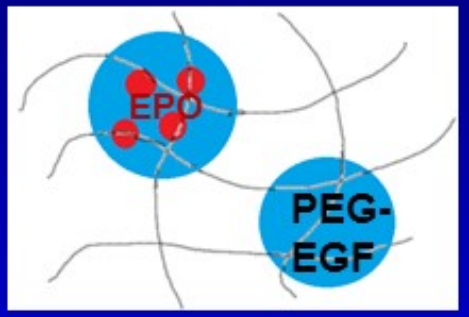
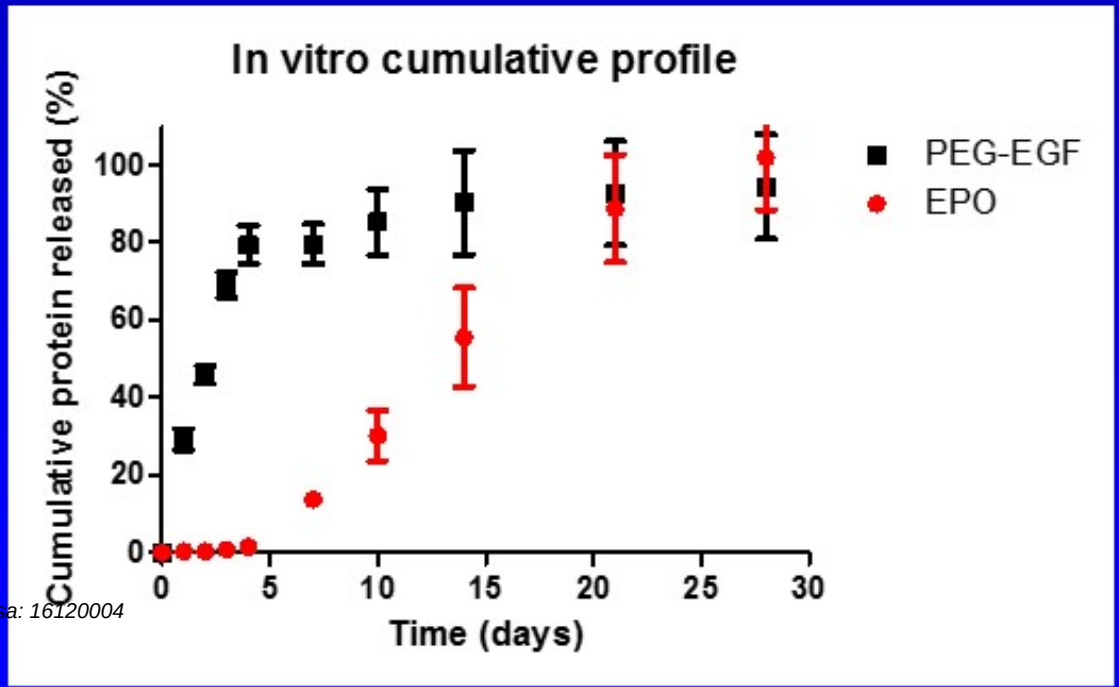
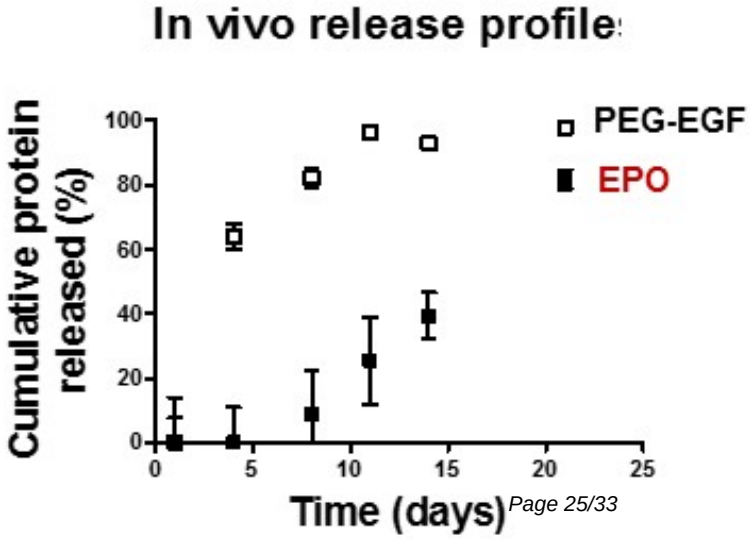
Sequential Delivery of PEG-EGF & EPO

- Delivery Profile Goal:
  - Release PEG-EGF for 7 days followed by EPO for 7 days
- Composite delivery system:
  - HAMC
  - Nanoparticles encapsulate PEG-EGF
  - Biphasic particles encapsulate EPO







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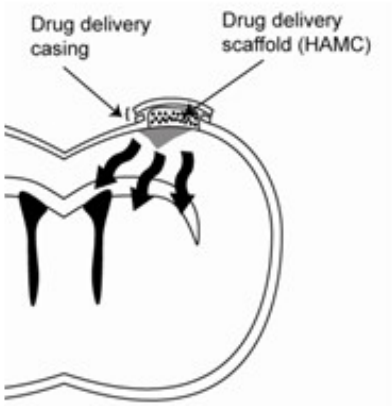
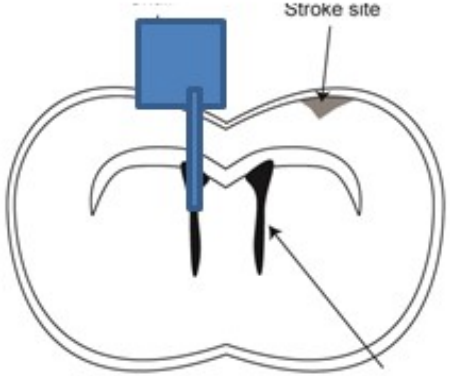
Hydrogel delivery vs. Catheter/pump

Composite DDS



Pump infusion



Day 0 | Day 4 | Day 11 | Day 18 | Day 32

PEG-EGF | EPO

Stroke

Cannula Implant

Implant pumps or composite DDS

Switch pumps

Remove pumps

Sacrifice

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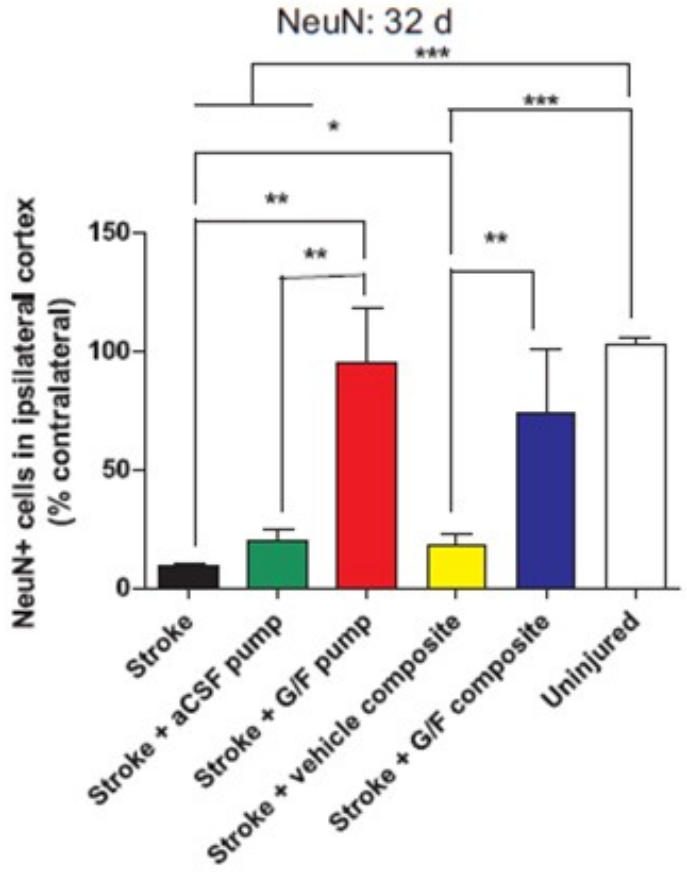
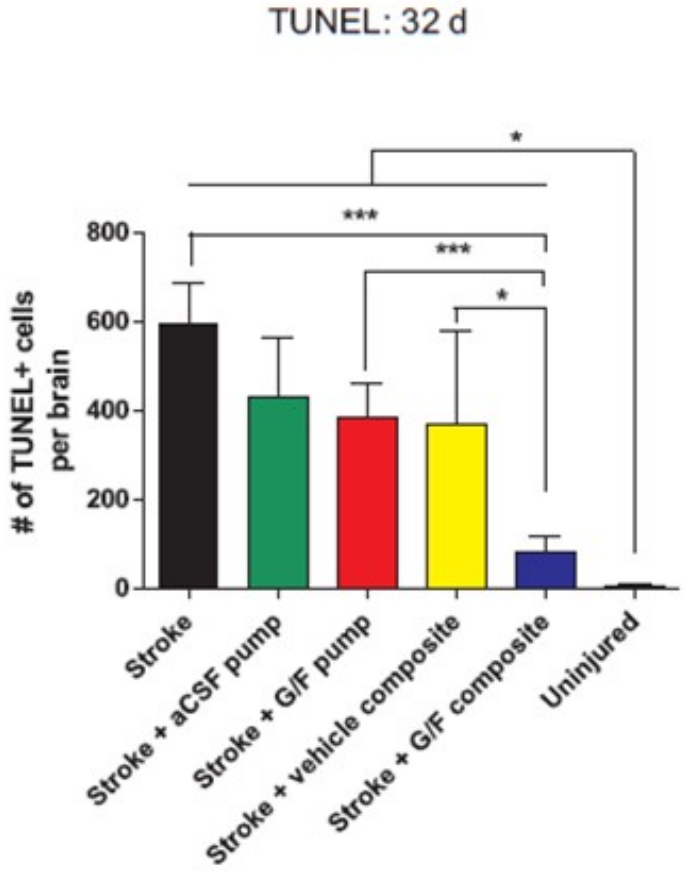
Brain Repair with Growth Factor Delivery

Hydrogel delivery vs. Catheter/pump

Same Nerve Tissue



Reduced Cell Death



Wang, Cooke et al *J. Control Rel* 2013

Change in Medicine

- Personalized Medicine

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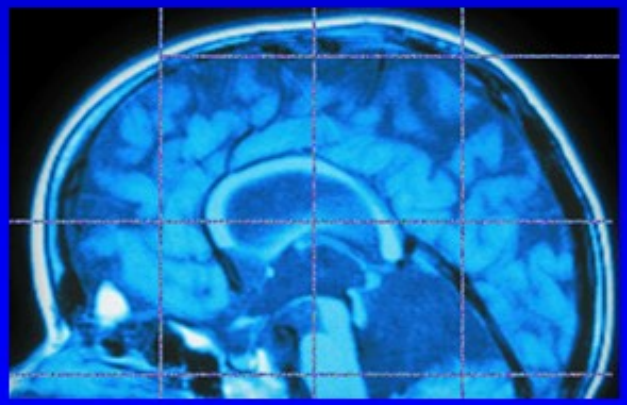
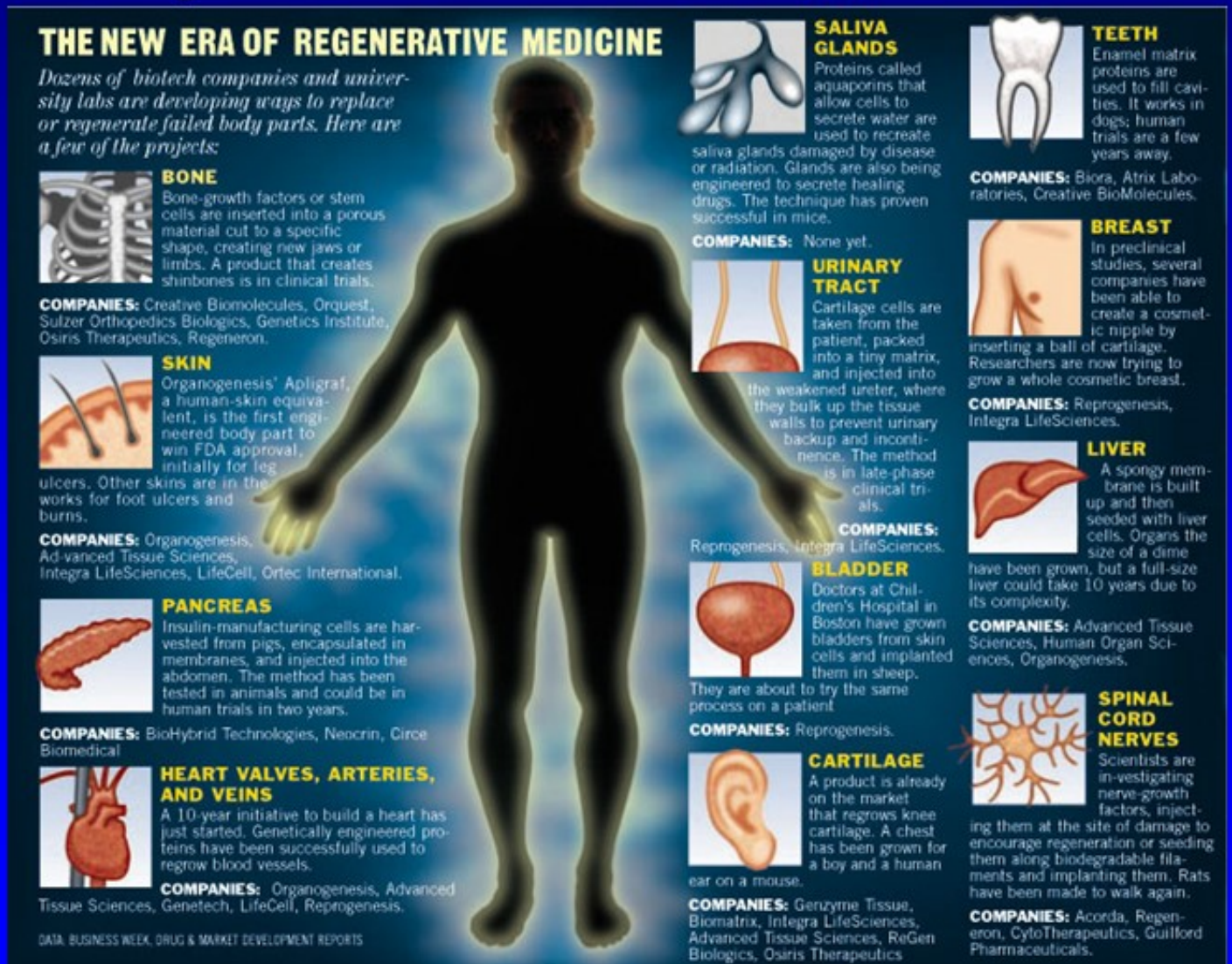
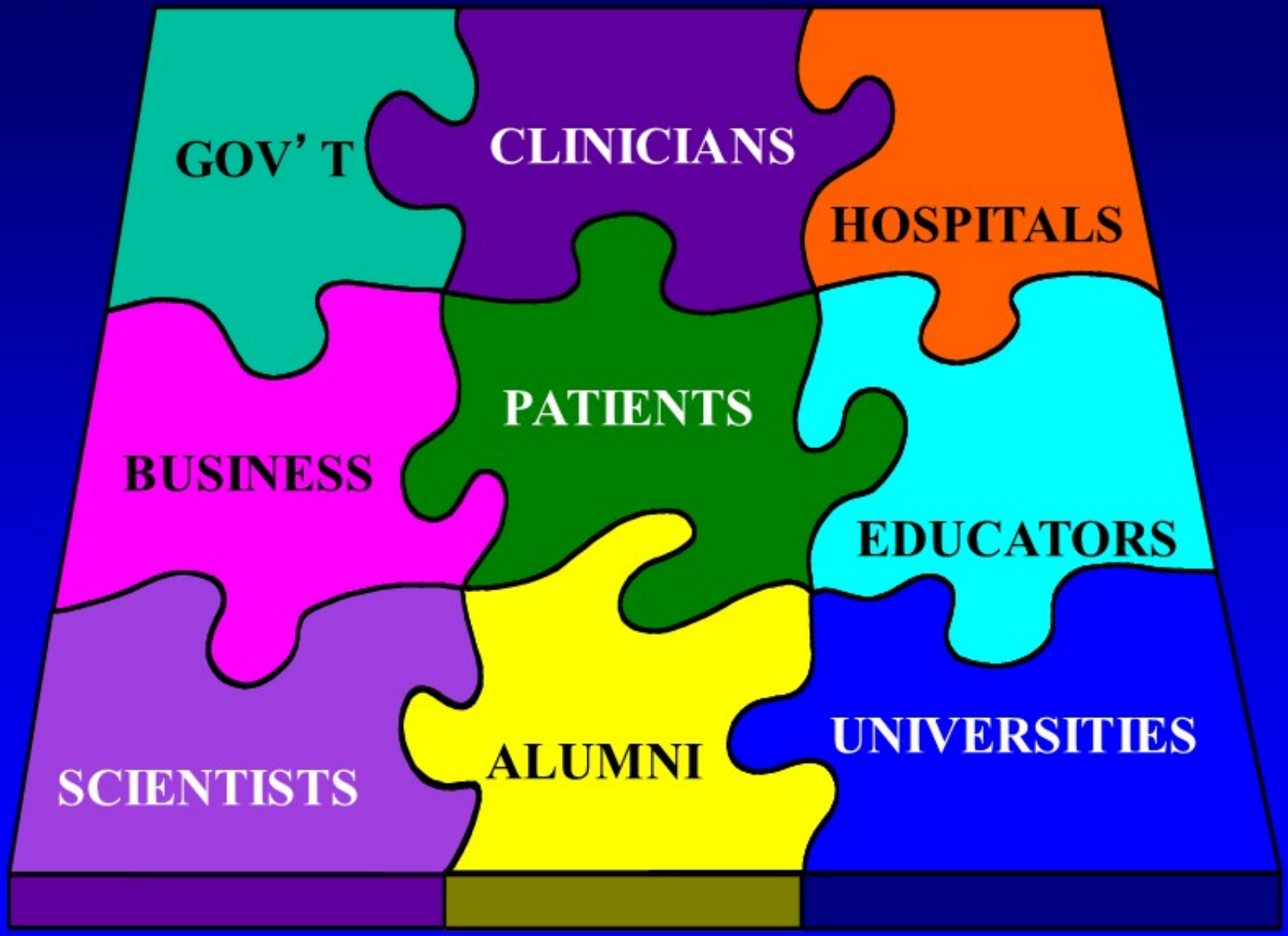


Restore, maintain and improve tissue function






La science
a besoin
des femmes
PRIX L'ORÉAL-UNESCO
Pr Molly S. Shoichet, Chimiste
Lauréate 2015, Canada

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Howard Kim
Catherine Kang
Michael Conrad
Meng Shi
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Ying Luo
Maria Jimenez-Haman
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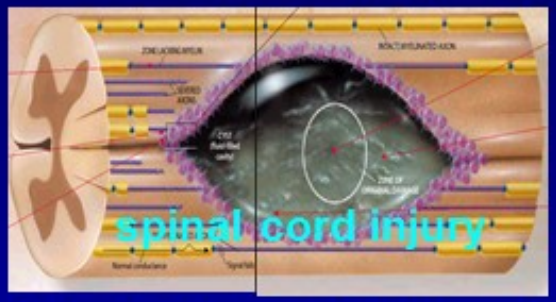

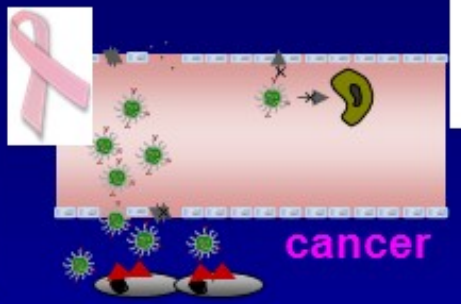

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Michael Fehlings (UHN)
Greg Borschel (HSC)

Cindi Morshead (UT)
Dale Corbett (UofO)

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Andras Nagy (MSH)
Valerie Wallace (UHN)

Dev Sidhu (UT)
Jason Moffat (UT)
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Brian Shoichet (UCSF)
Tad Koch (UColorado)
Armand Keating (PMH)
Kevin Petrecca (McGill)
Rima Al-awar (OICR)

Tissue Mimetics
Karen Maxwell (UT)
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Bill Stanford (UOttawa)

Alzheimer's Disease
Peter Hyslop (UT)
Paul Fraser (UT)
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