Way to the future
Intersection of Nanotechnology and Healthcare

Nanomedicine Translational Think Tank

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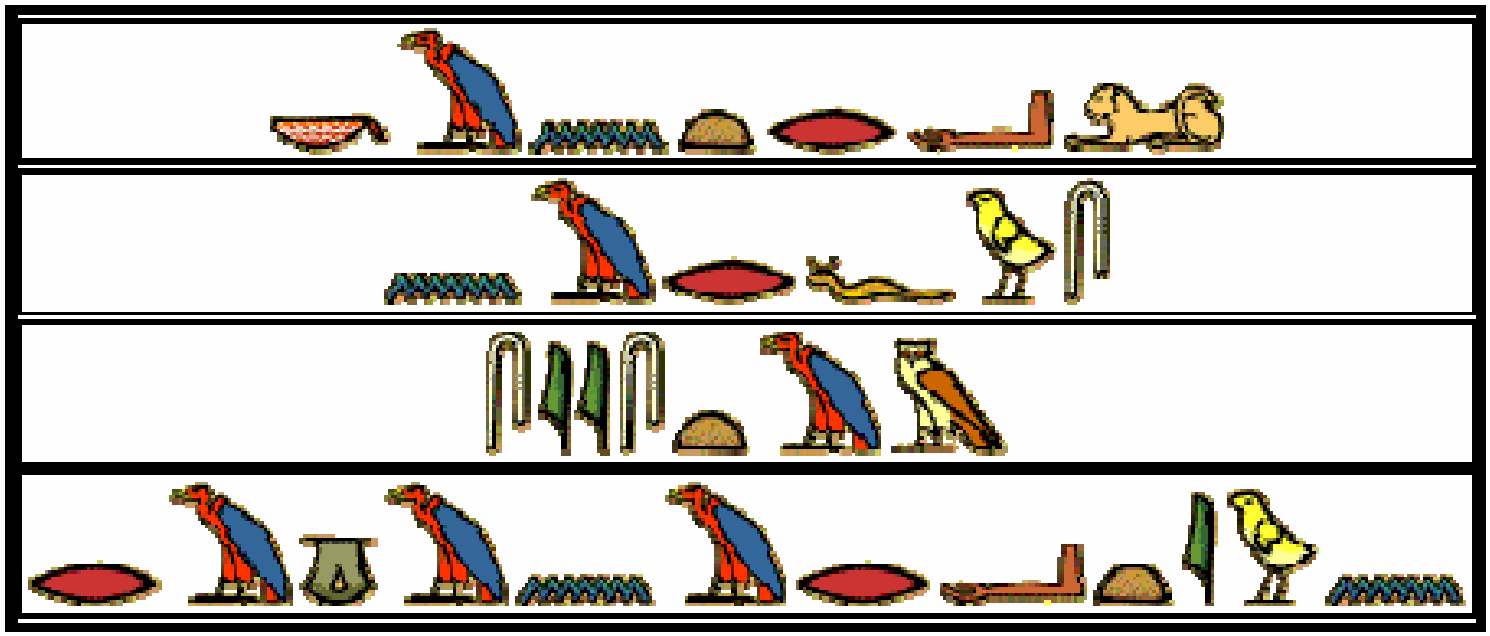
Financial Disclosure

- I have financial interests:
  - Founder, shareholder in Clear Nano Solutions, Inc.
  - Arch Therapeutics
  - Shareholder in 3D Matrix Japan
  - Patents at MIT and HKU

CNS Regeneration *translated to Hieroglyphics inspired by the Edwin Smith Papyrus* approx 3000B.C.



Topics

- Intersection of nanotechnology and healthcare
- Safety of nanomedicines
- Challenges in translational development
- Bottlenecks in regulation

FDA Guidelines Effective June 3-2010

- CENTER FOR DRUG EVALUATION AND RESEARCH MAPP 5015.9
- Originator: Office of Pharmaceutical Science
- Reporting Format for Nanotechnology-Related Information in CMC Review
- It is a great start and allows for flexibility

Areas that have a component of nanotechnology

- **Biopharmaceutics**
  - Drug delivery
  - Drug encapsulation
  - Functional drug carriers
  - Drug discovery
- **Implantable Materials**
  - Tissue repair and replacement
  - Implant coatings
  - Tissue regeneration scaffolds
  - Structural implant materials
  - Bone repair
  - Bioresorbable materials
  - Smart materials
- **Implantable Devices**
  - Assessment and treatment devices
  - Implantable sensors
  - Implantable medical devices
- **Sensory Aids**
  - Retinal implants
  - Cochlear implants
- **Surgical Aids**
  - Operating Tools
  - Smart Instruments
  - Surgical robots
- **Diagnostic Tools**
  - Genetic testing
  - Ultra-sensitive labeling and detection technologies
  - High throughput arrays and multiple analyses
- **Imaging**
  - Nanoparticle labels
  - Imaging devices

Adaptable materials for uses in living organisms vs. non-living

- One product many uses
  - i.e. Dendrimers with different active groups
- Self assembling materials
- Disassembling materials
- Warming / cooling
- Protective at different temperatures
- Hydrating versus dehydrating
- Chelating in mining operations
- Recoverable / recyclable
- Consumable
  - Human, Plant, cell ?

Medical devices

- Macro
  - Implantable defibrillators, help prevent, diagnose, treat and monitor
- Nano
  - Implantable structure that will allow for dynamic reconfiguration during use, breakdown when finished, and be excreted

Nanotechnology

- Using molecules as building blocks to build structures

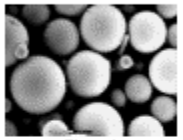
The Scale of Things -- Nanometers and More

Things Natural

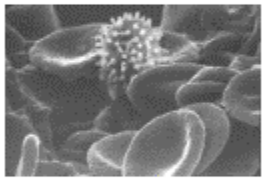
Dust mite
200 µm

Ant
~ 5 mm

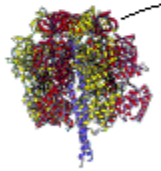
Human hair
~ 10-50 µm wide



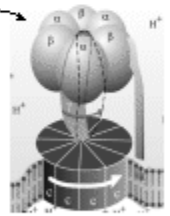
Fly ash
~ 10-20 µm



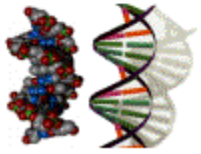
Red blood cells with white cell
~ 2-5 µm



~10 nm diameter

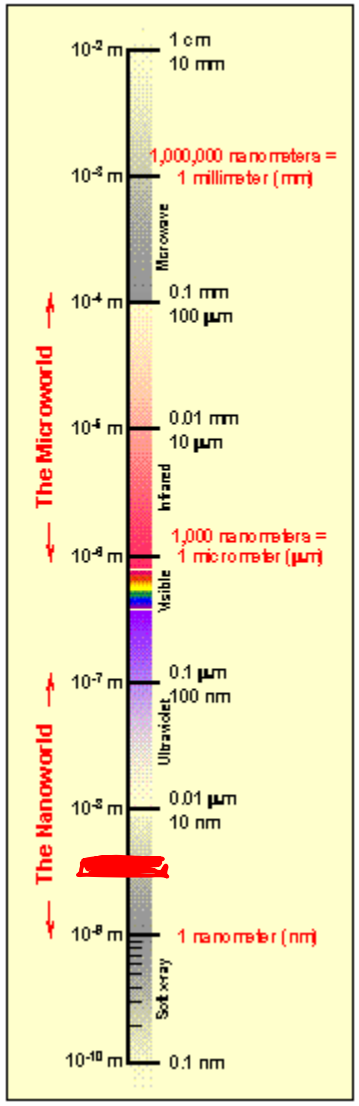


ATPsynthase

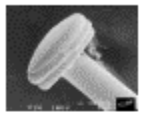


DNA
~2-12 nm diameter

Atoms of silicon
spacing ~tenths of nm

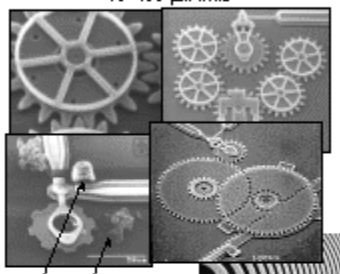


Things Manmade

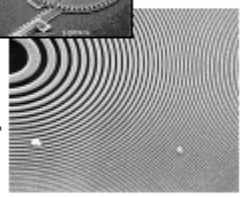


Head of a pin
1-2 mm

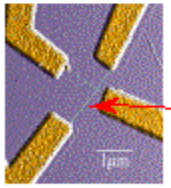
Micro Electro Mechanical devices
10 -100 µm wide



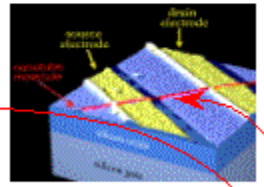
Red blood cells
Pollen grain



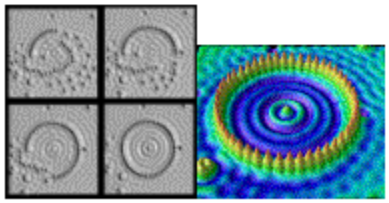
Zone plate x-ray "lens"
Outermost ring spacing
~35 nm



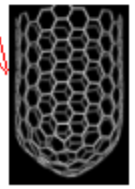
Nanotube electrode



Nanotube transistor

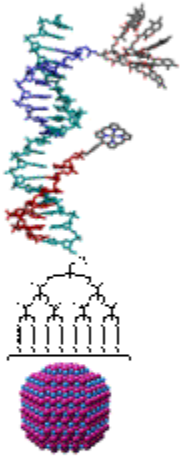


Quantum corral of 48 iron atoms on copper surface
positioned one ata time with an STM tip
Corral diameter 14nm



Carbon nanotube
~2 nm diameter

21st Century Challenge



Combine nanoscale building blocks to make novel functional devices, e.g., a photosynthetic reaction center with integral semiconductor storage

Nanotechnology

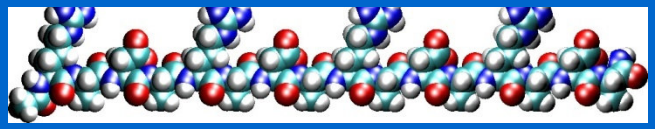
- Materials Dendrimers / Chips
- Imaging Grin Lenses
- Delivery Coatings
- Manipulation AFM
- Forces Van der waals
- Structures Self assembled
- Old is now new Size and localization really matters

Building Structure with molecules

- The structure that is built
  - is self assembled
- It is not causing secondary signaling
- It allows for healing and CNS regeneration

Technology: *Nanoscale Self-Assembling Peptide*

SAPNS 5 nm

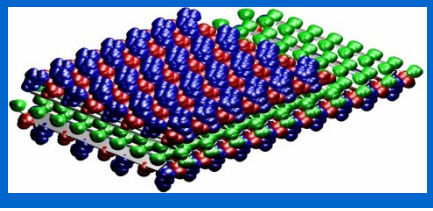


1% in DI H20

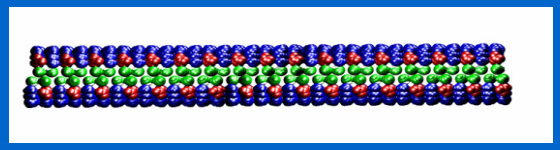
Add to wound

Ionic Fluid

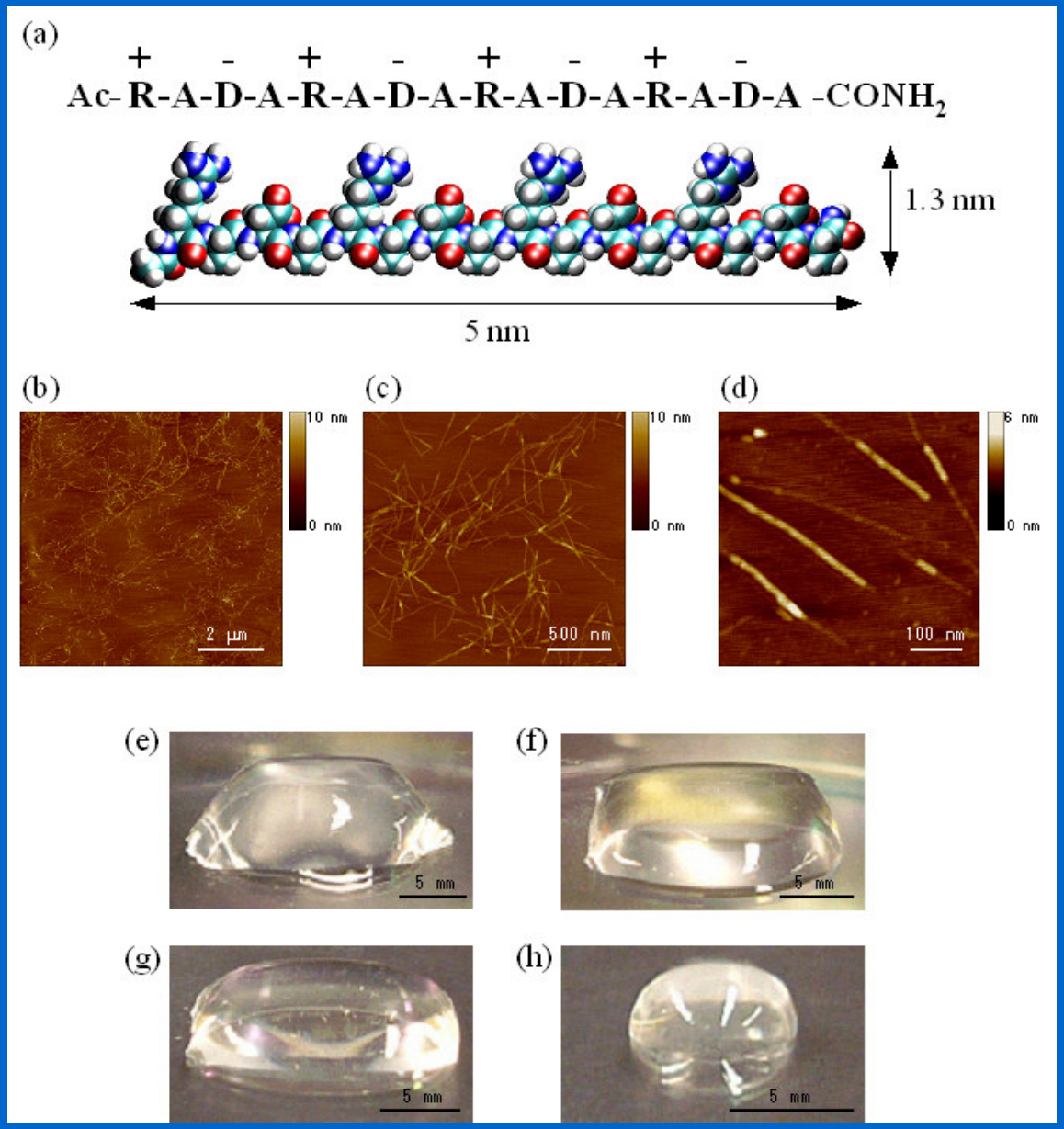
Results in self-assembly



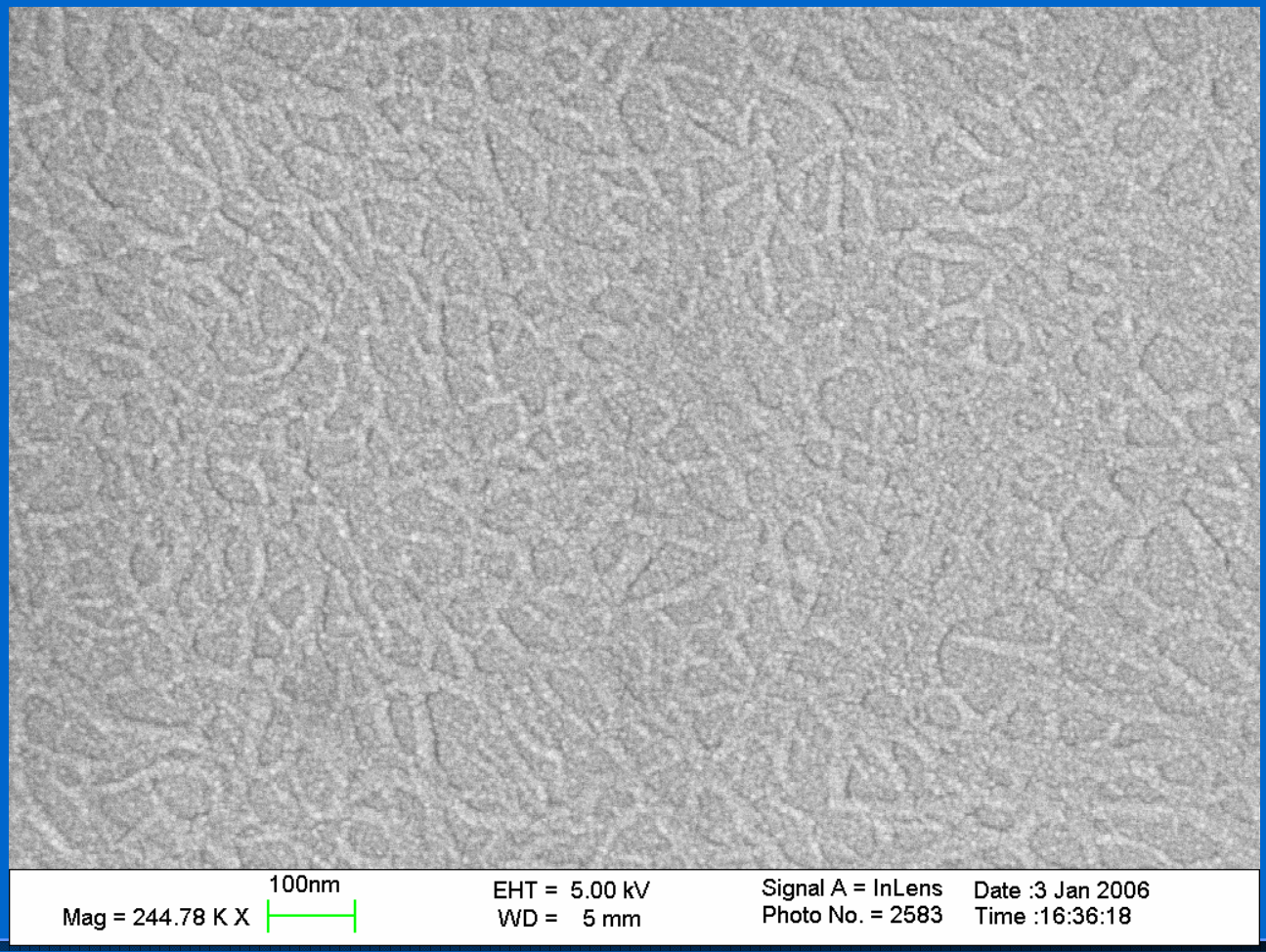
Self-assembly happens in 5 seconds in a wet environment.



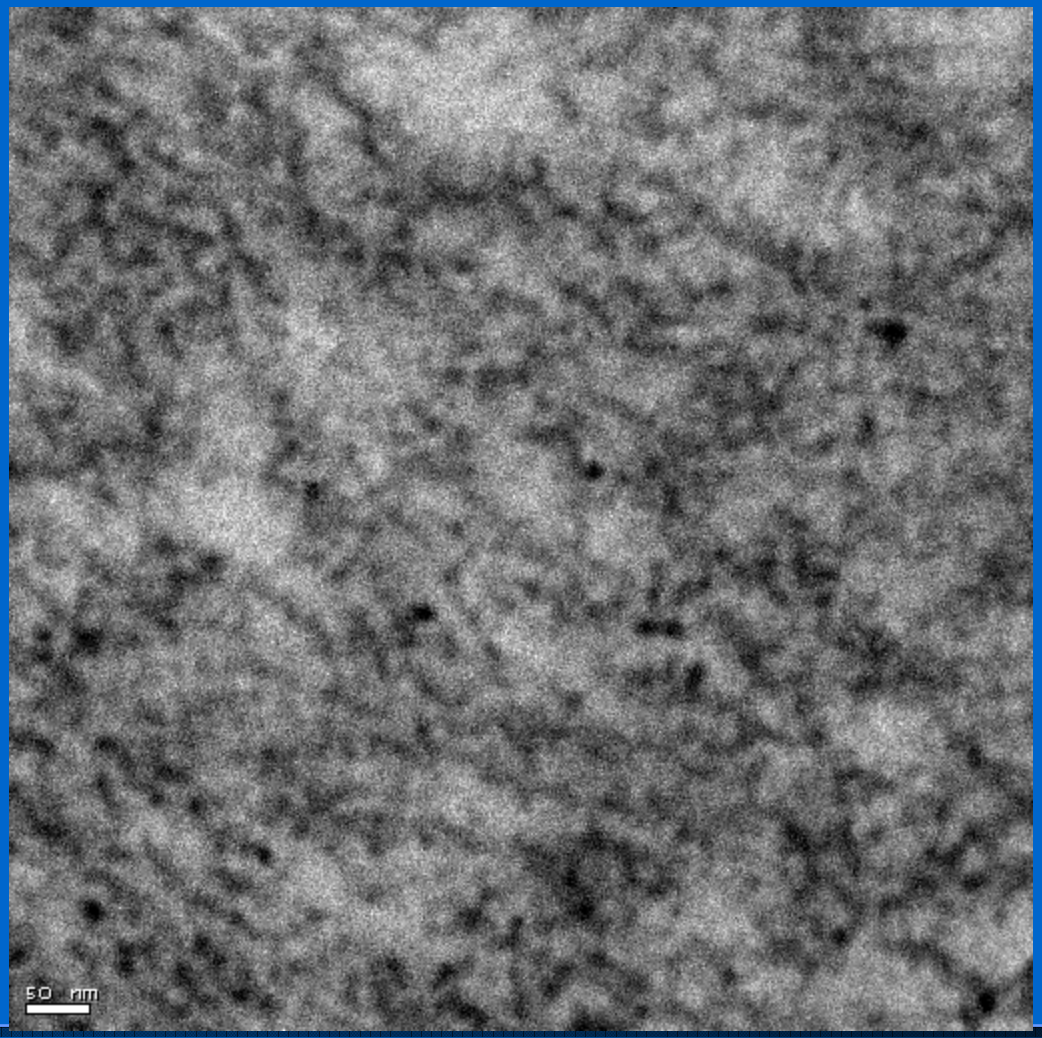
Healing starts when applied


(a)
+ - + - + - + -
Ac-R-A-D-A-R-A-D-A-R-A-D-A-R-A-D-A-CONH2
1.3 nm
5 nm
(b)
10 nm
0 nm
2 μm
(c)
10 nm
0 nm
500 nm
(d)
8 nm
0 nm
100 nm
(e)
5 mm
(f)
5 mm
(g)
5 mm
(h)
5 mm

Environmental SEM
3% material assembled



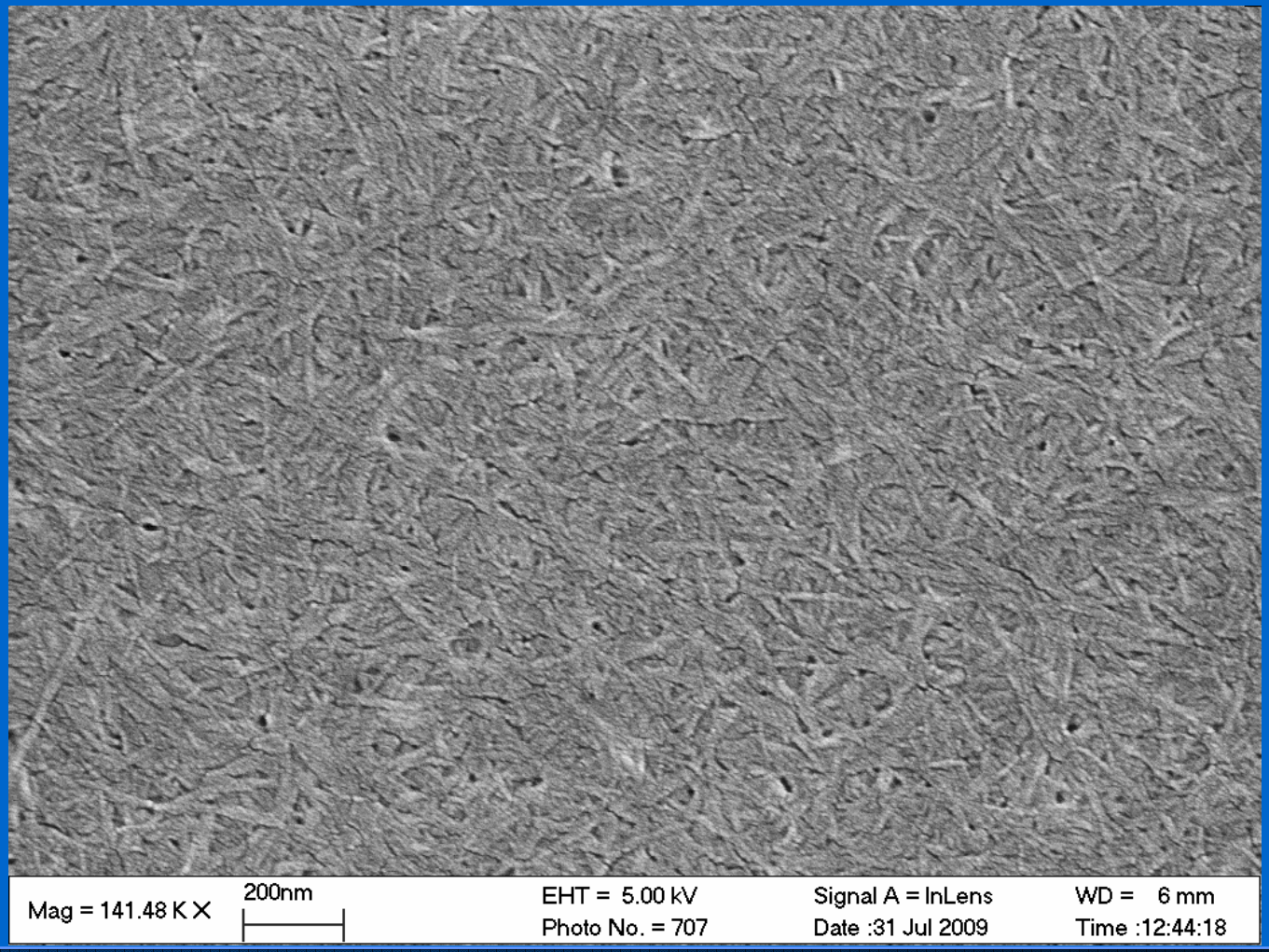
EM of 3% SAPNS in-vivo cortex



50 nm

Scale

Smart Environments



Bamboo Scaffolding

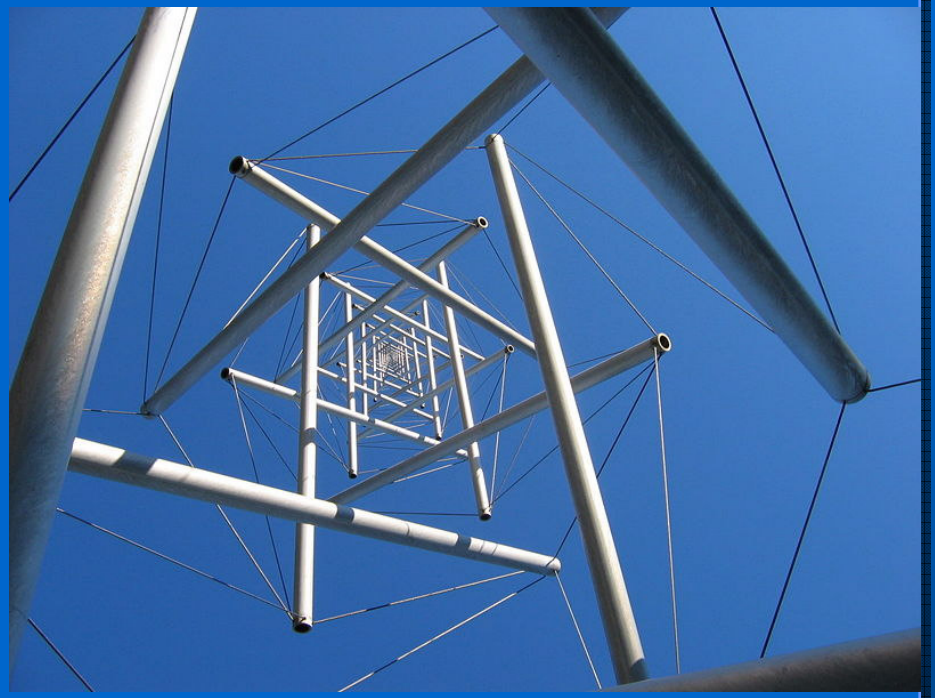
Intersection of nanotechnology and healthcare

- Can a molecule be a medical device but not a drug?
- Is physical restriction a drug, therapeutic, neither, or both?

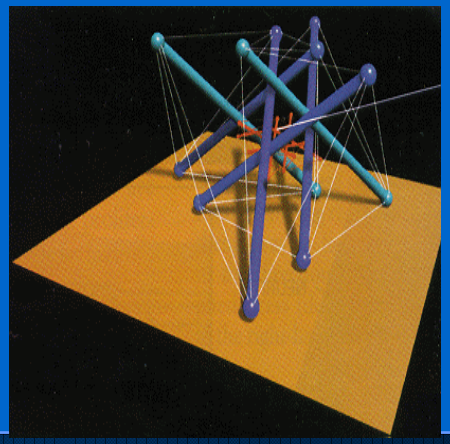
The modulus of the biomaterial must be matched to the tissue

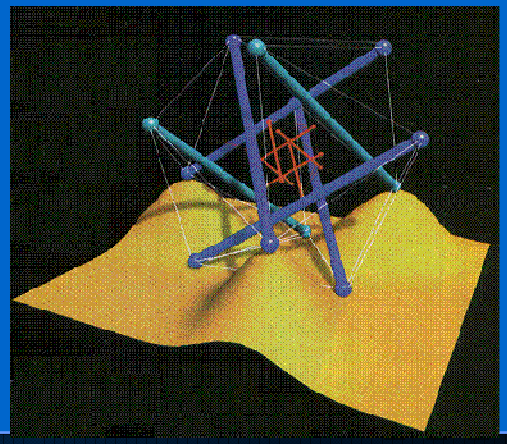
- The tissue modulus may change with injury
- How will different densities affect the growth of cells?

Tensegrity



- based on a synergy between balanced tension and compression components.
- Don Ingber
- Internal





Growth and survival of PC12/neural precursor/stem cells in three dimensional cultures

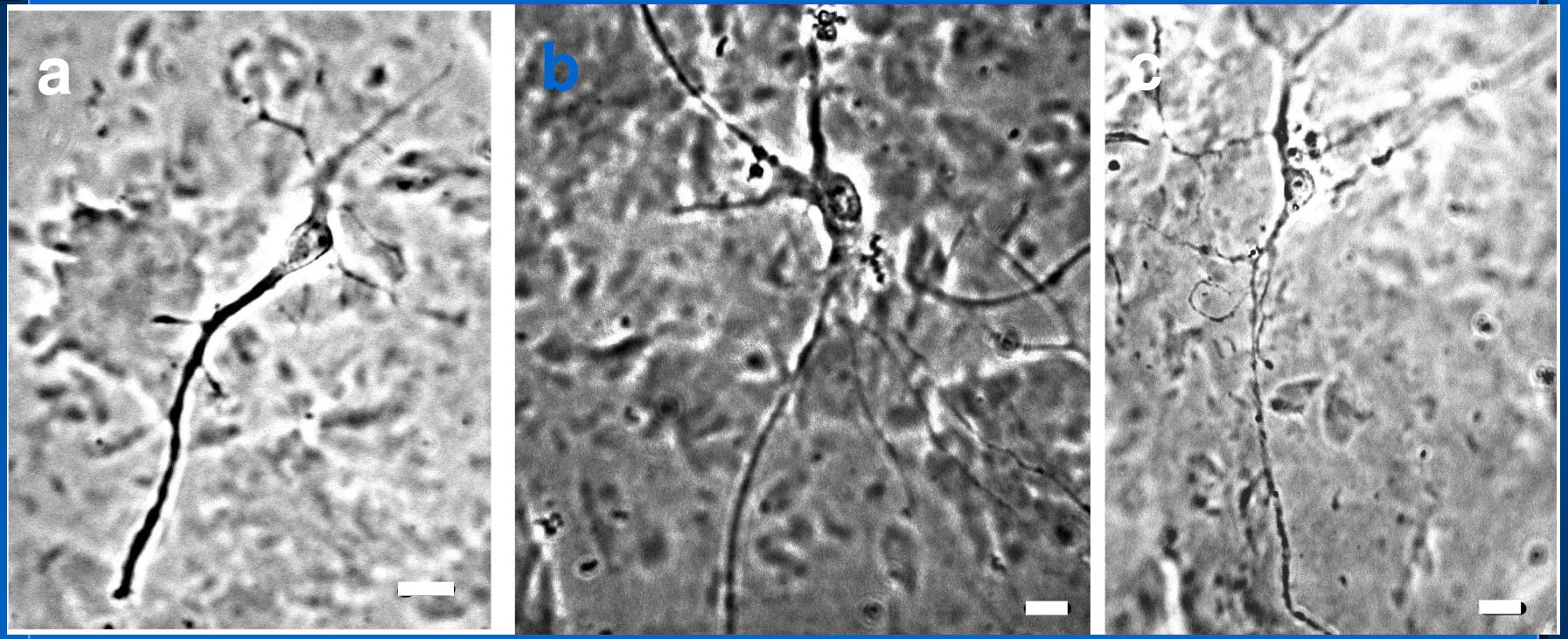
Questions that need to be answered

- What happens when you change the physical or chemical environment?
  - 1% SAPNS with and without serum
  - 2% SAPNS with and without serum
  - 3% SAPNS with and without serum
- Does it mimic the natural ECM?
- Bone vs. neural tissues
- What shape are the neurons in natural tissue?

PC12 cells

- In vitro
- They divide/grow to confluence and then stop
- Contact inhibition
- What happens when you put them in different environments?

3D Cultured PC12 cells SAPNS



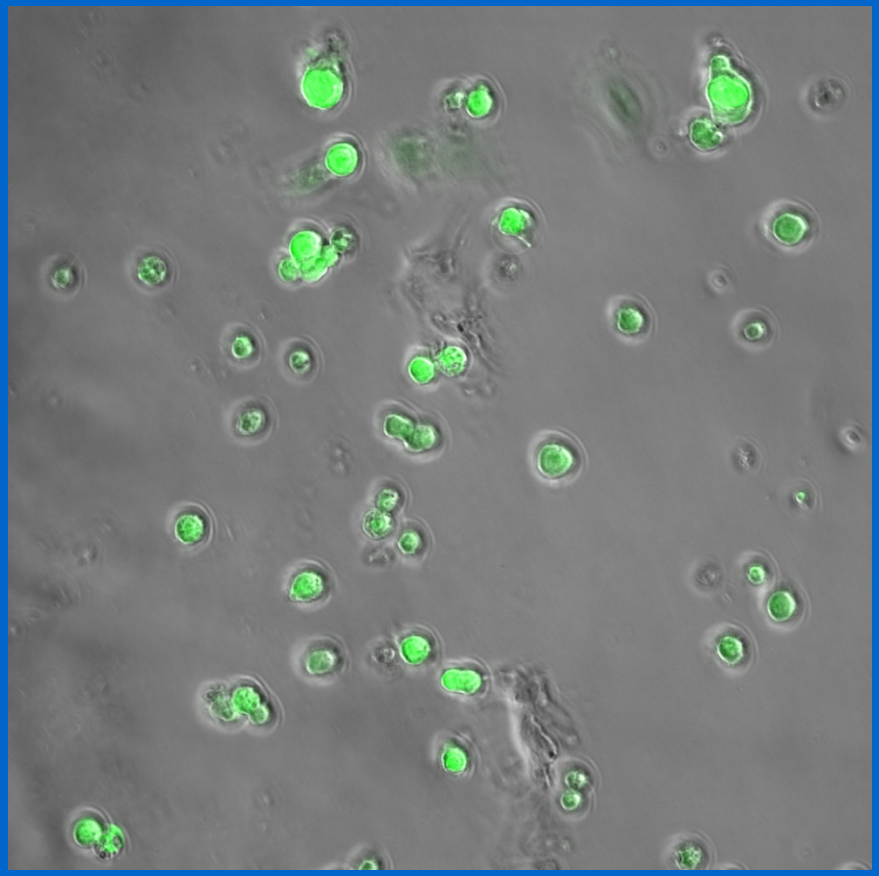
2% SF 2% WS 1% SF

Fig.1

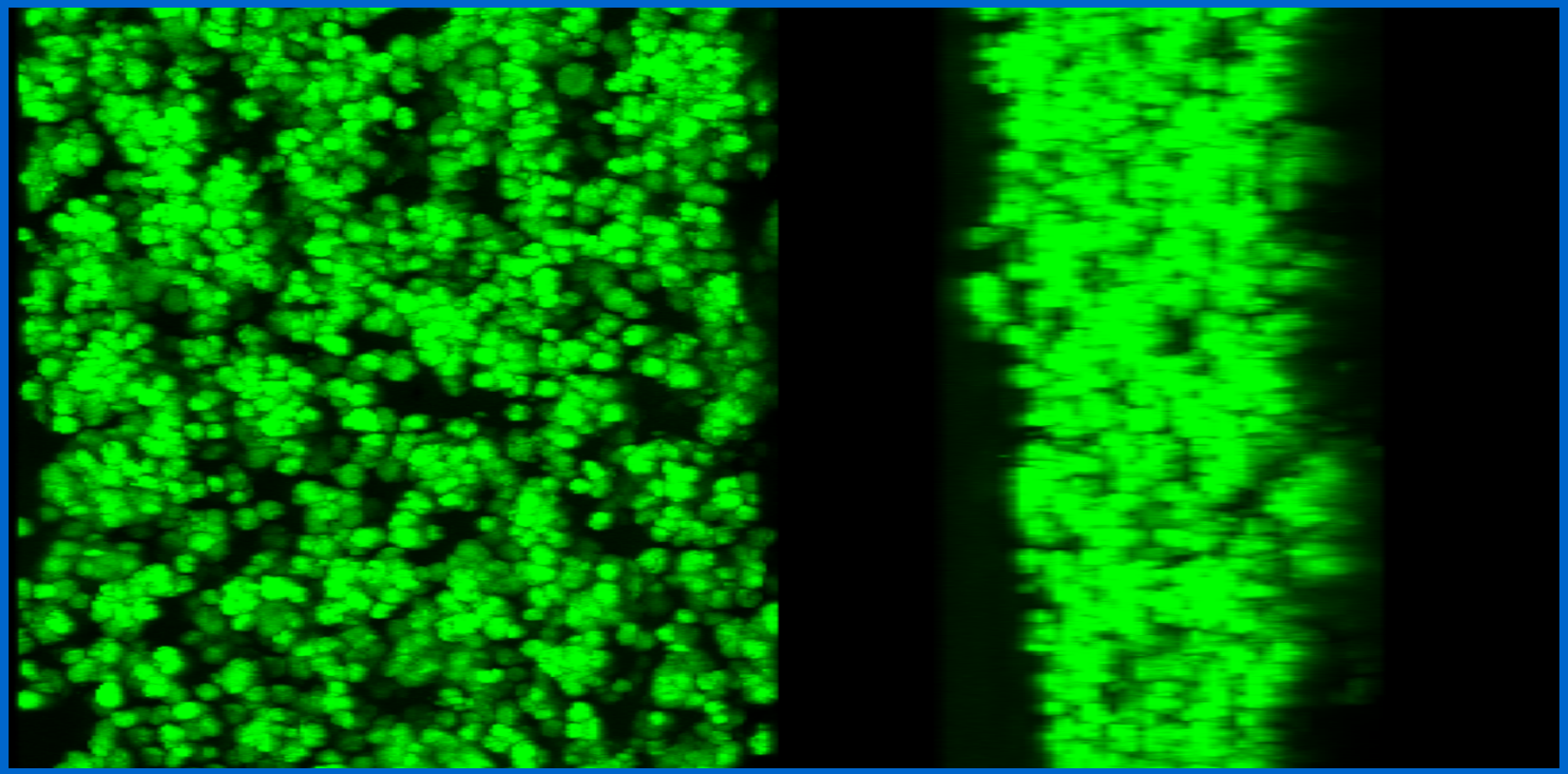
Primary cell 3 dimensional cultures

- What seeding density is needed?
- How high can you go?
- Do you get the same morphological changes?

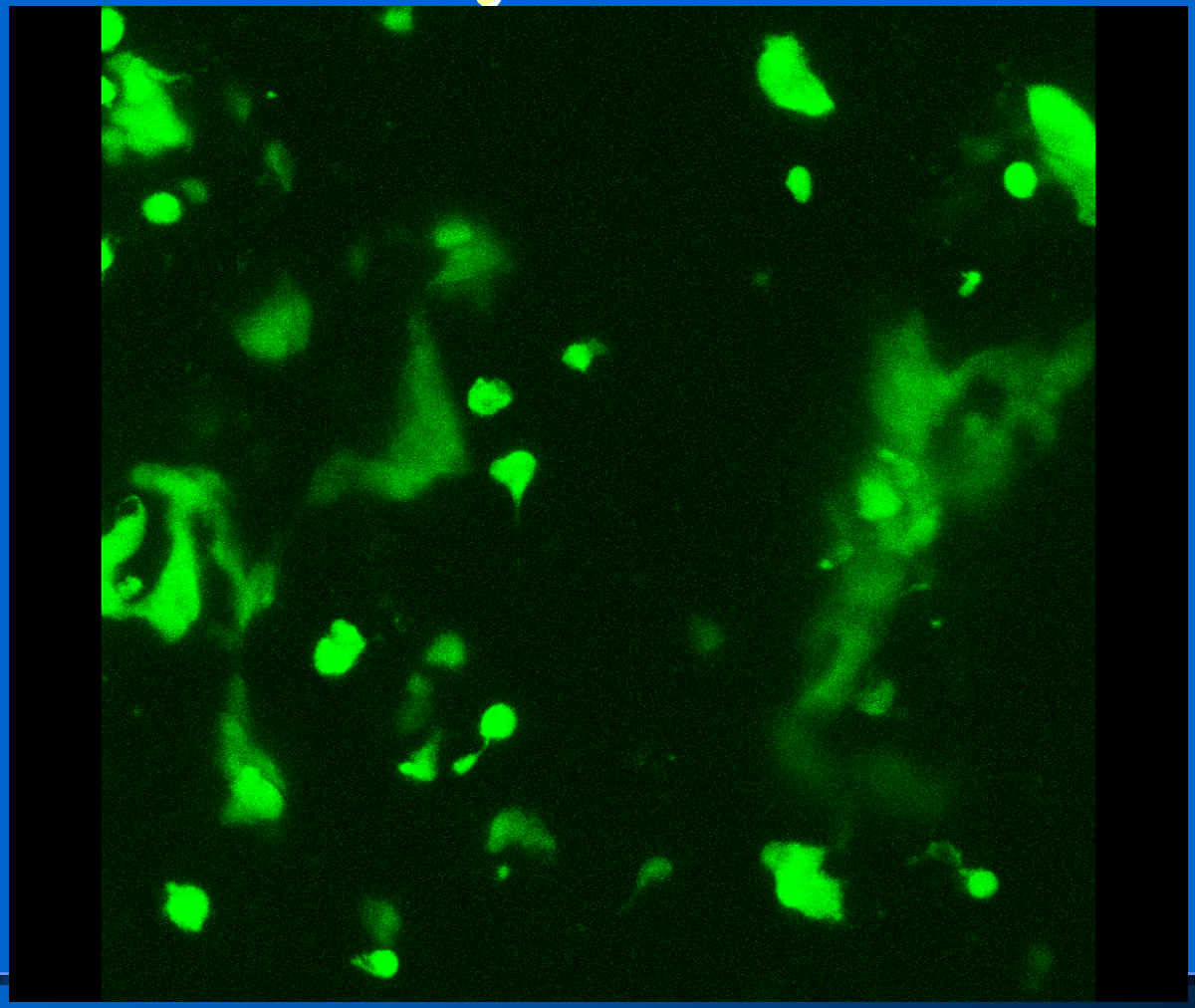
Primary cells seeded at low density in 1%



Stem cell culture in artificial ECM
10 million cells in 1% SAPNS
Day Zero

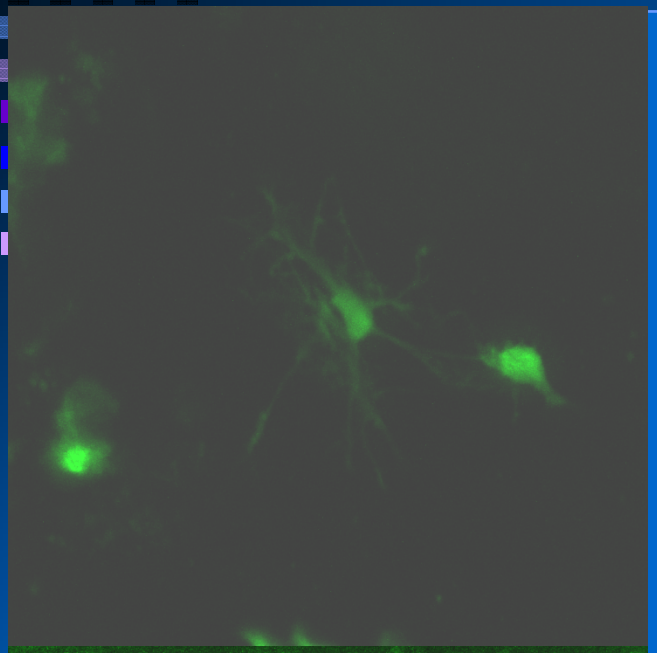


Stem cell culture in artificial ECM
3 day 1% SF

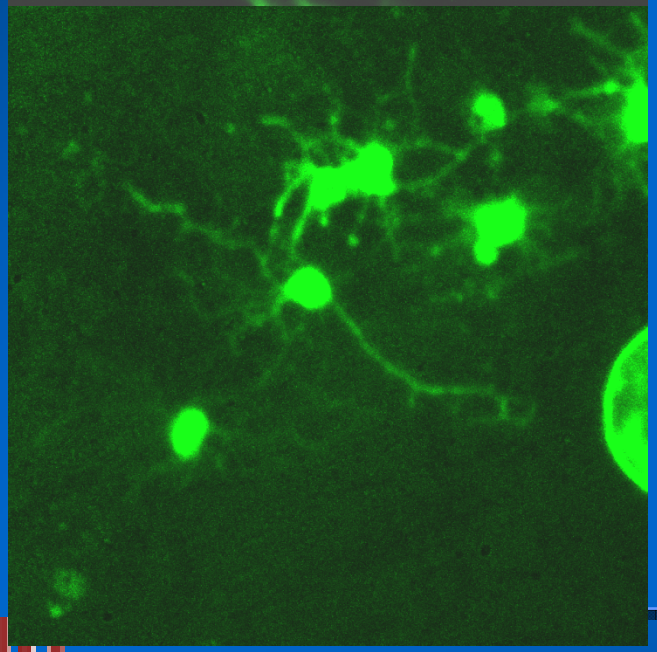


Stem cell culture in artificial ECM Day 7

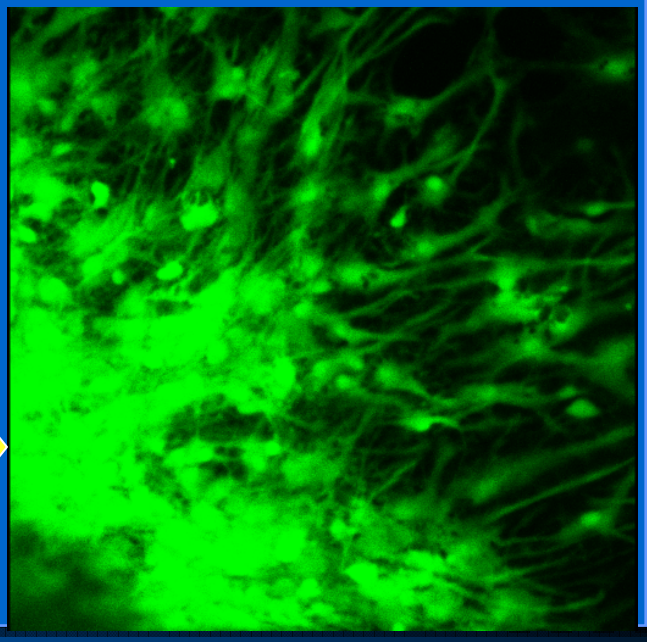
1% WS



2% WS

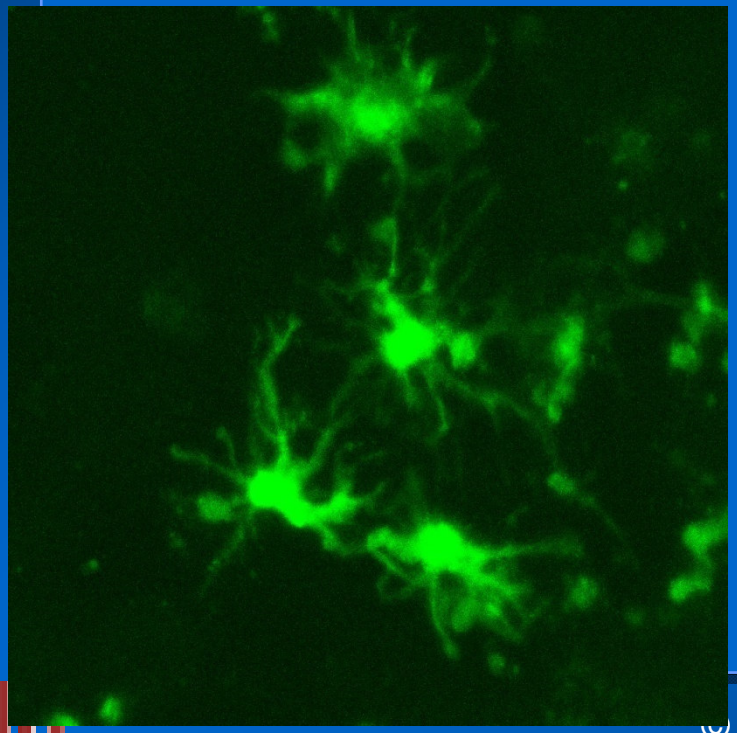


3% WS

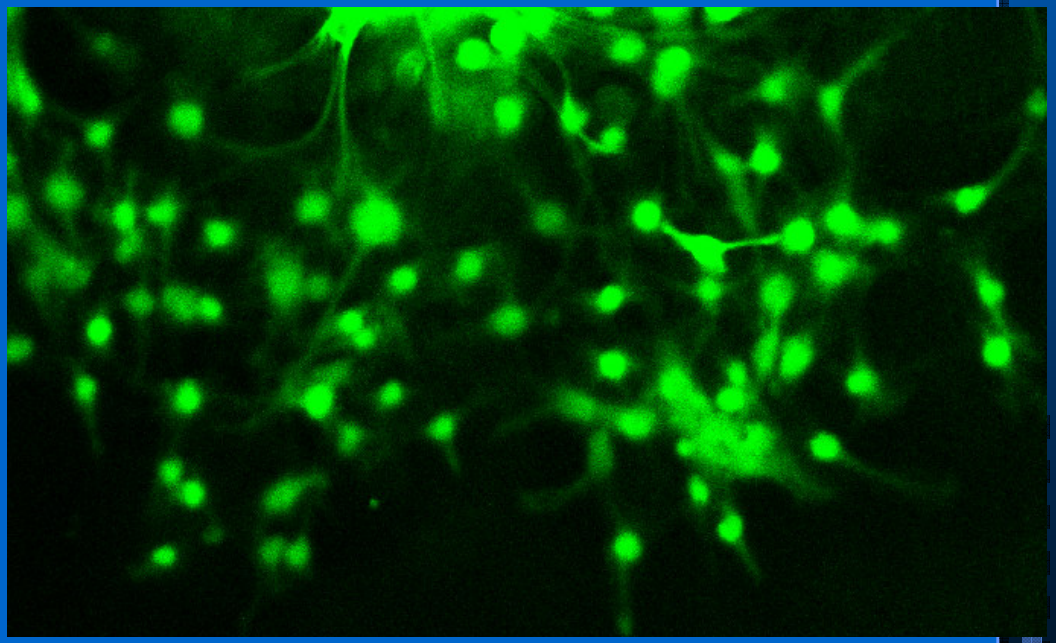


Stem cell culture in artificial ECM
Day 15 1%

WS

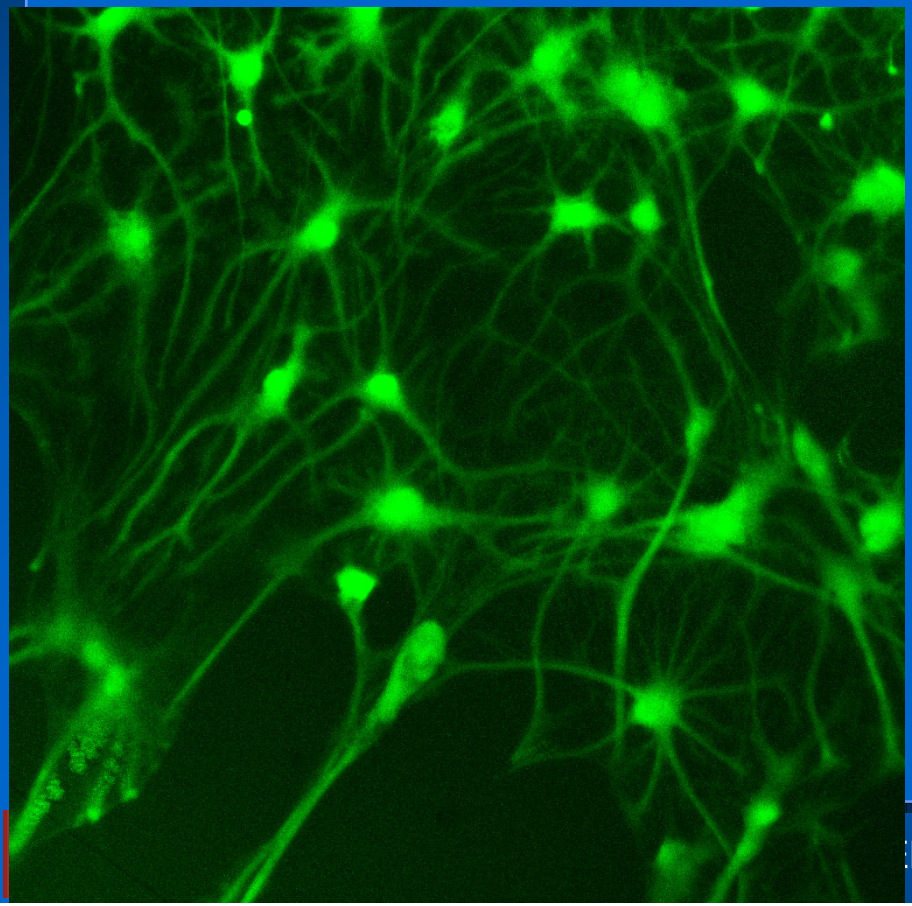


SF

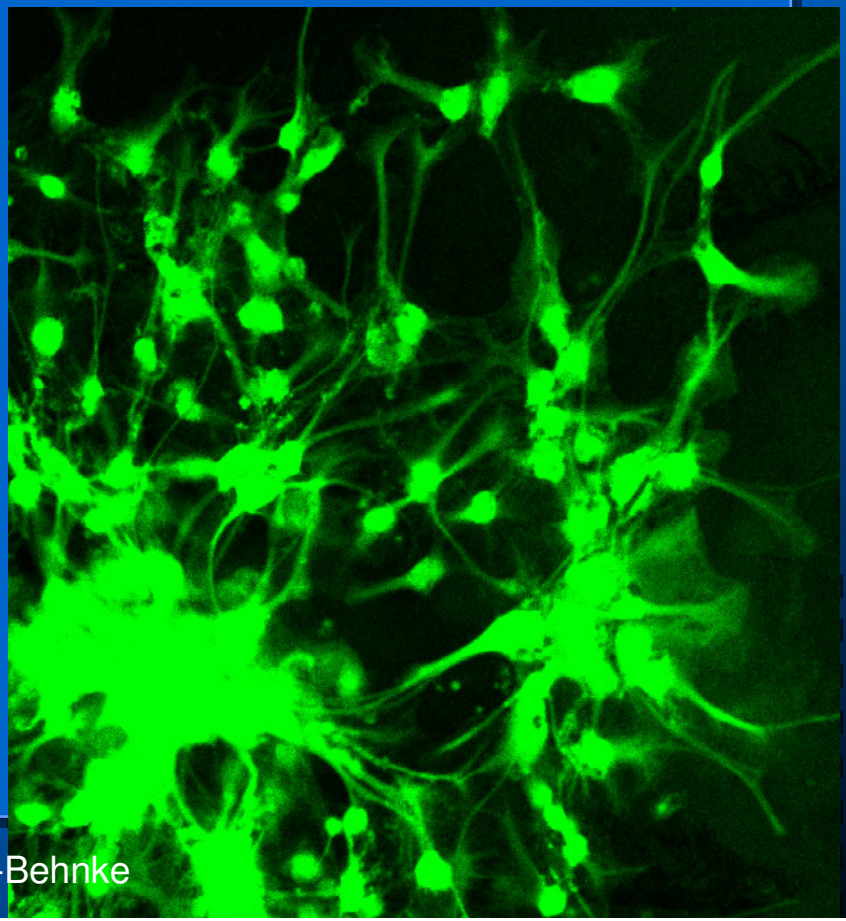


Stem cell culture day 15
3% SAPNS

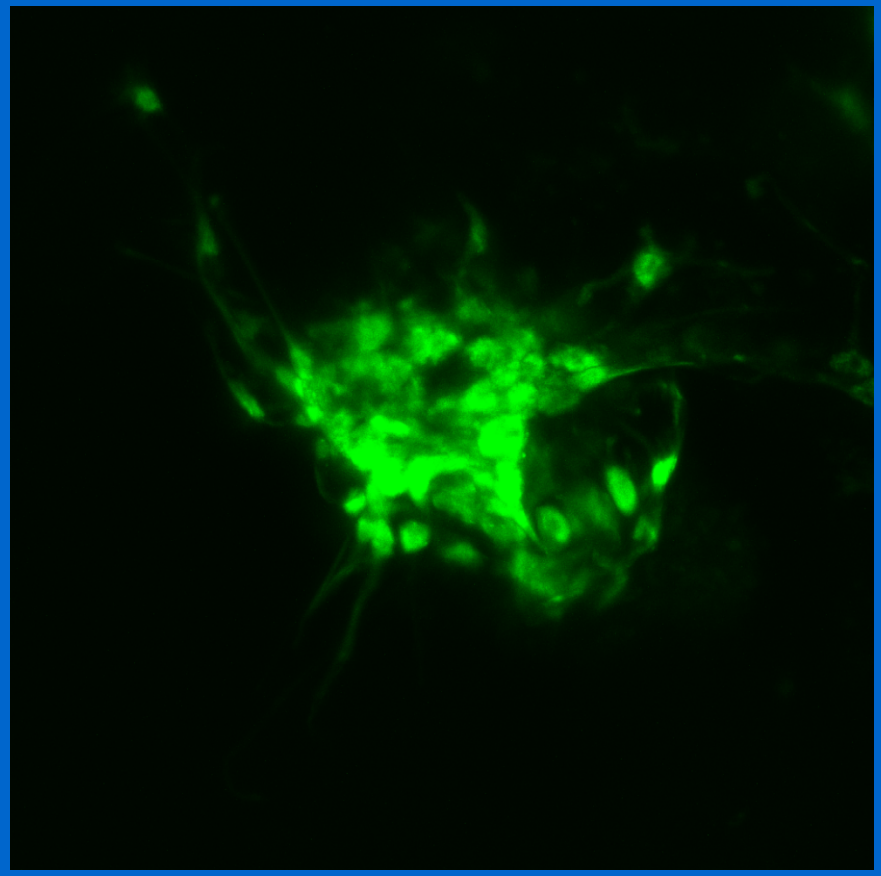
WS



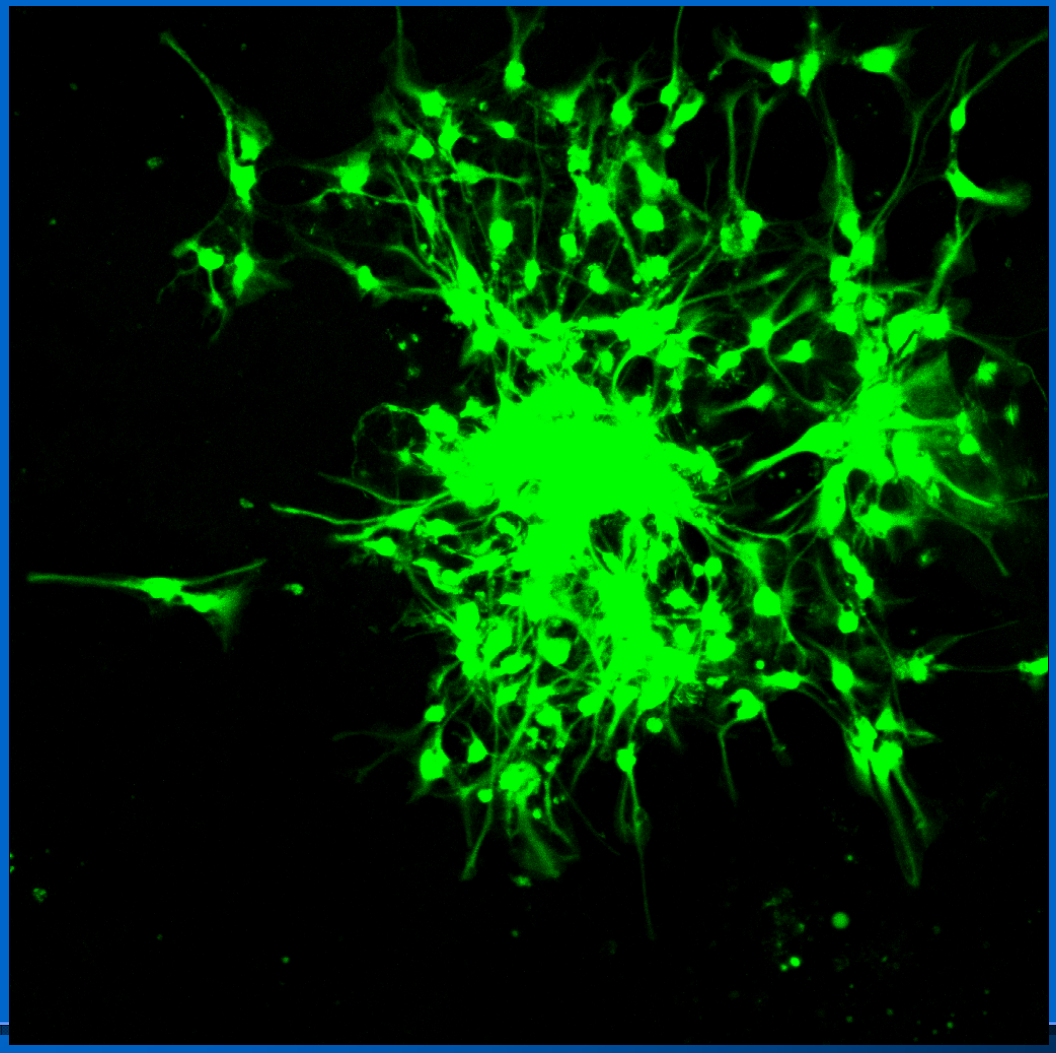
SF



Stem cell culture in artificial ECM
1 month 2% SF



Stem cell culture in artificial ECM
1 month serum free



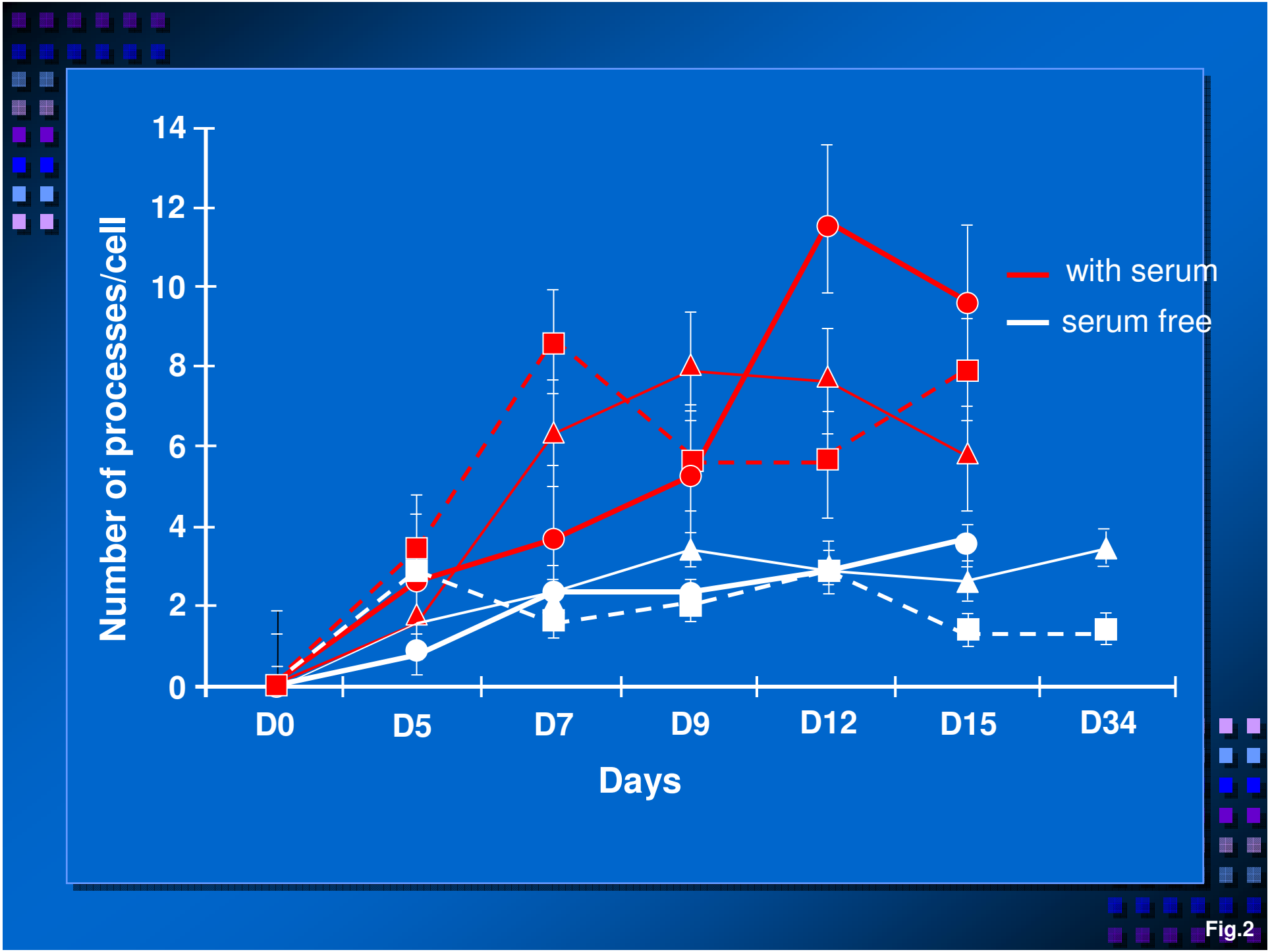
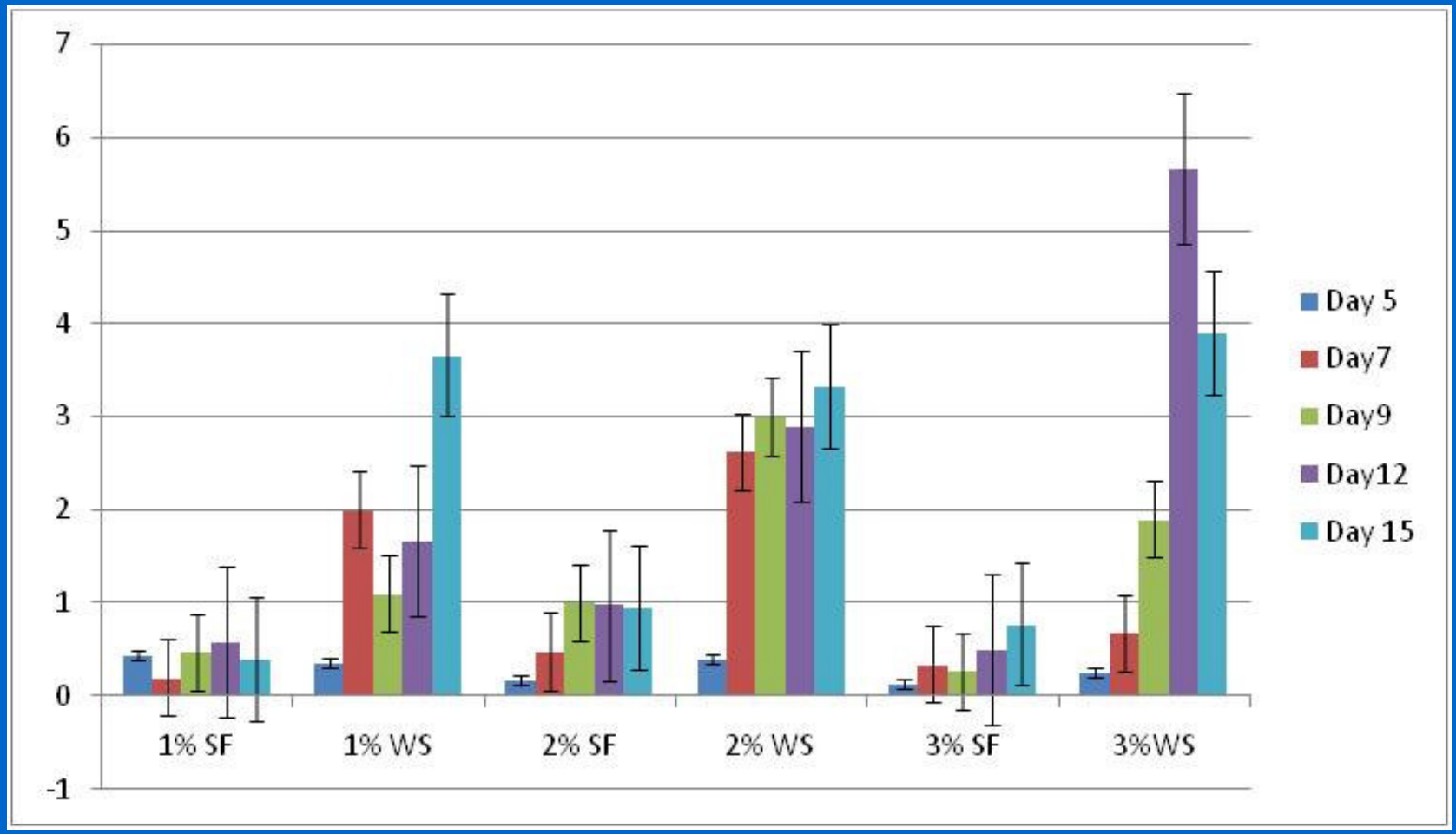

Number of processes/cell
14
12
10
8
6
4
2
0
D0
D5
D7
D9
D12
D15
D34
Days
with serum
serum free

Fig.2

Number of branches per process



Summary

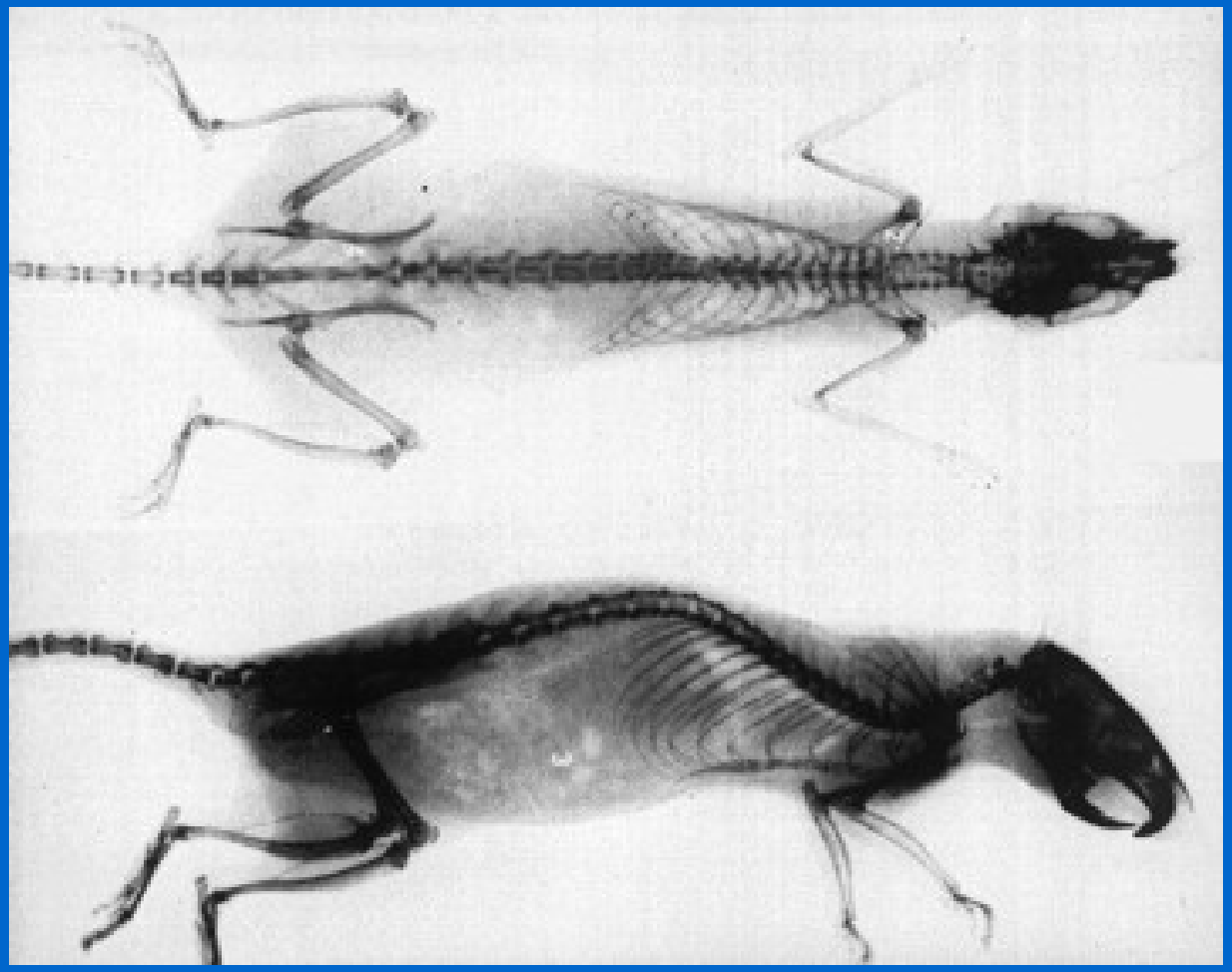
- As concentration of SAPNS increases the size of the process increases WS and SF.
- As the concentration of SAPNS increases the response to serum is delayed.
- Serum Free environments have significantly lower numbers of processes
- Structure appears to change the cellular response to growth

We have only changed the environment

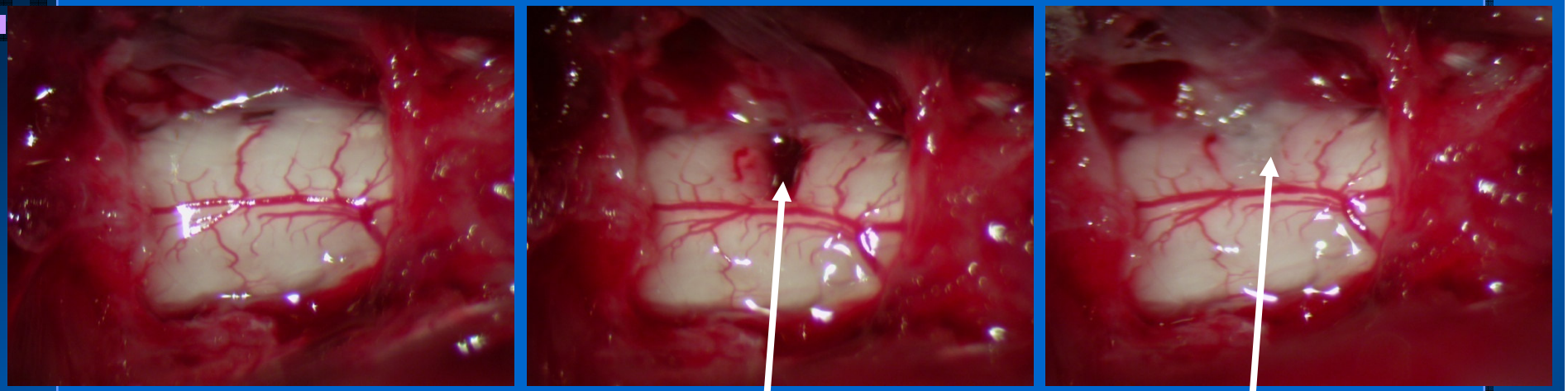
- Should this have additional regulation?
- Should a bandage?
- Probably not

Spinal Cord Repair

X-ray of rat skeleton location of hemi section



Hemi section model and transplantation

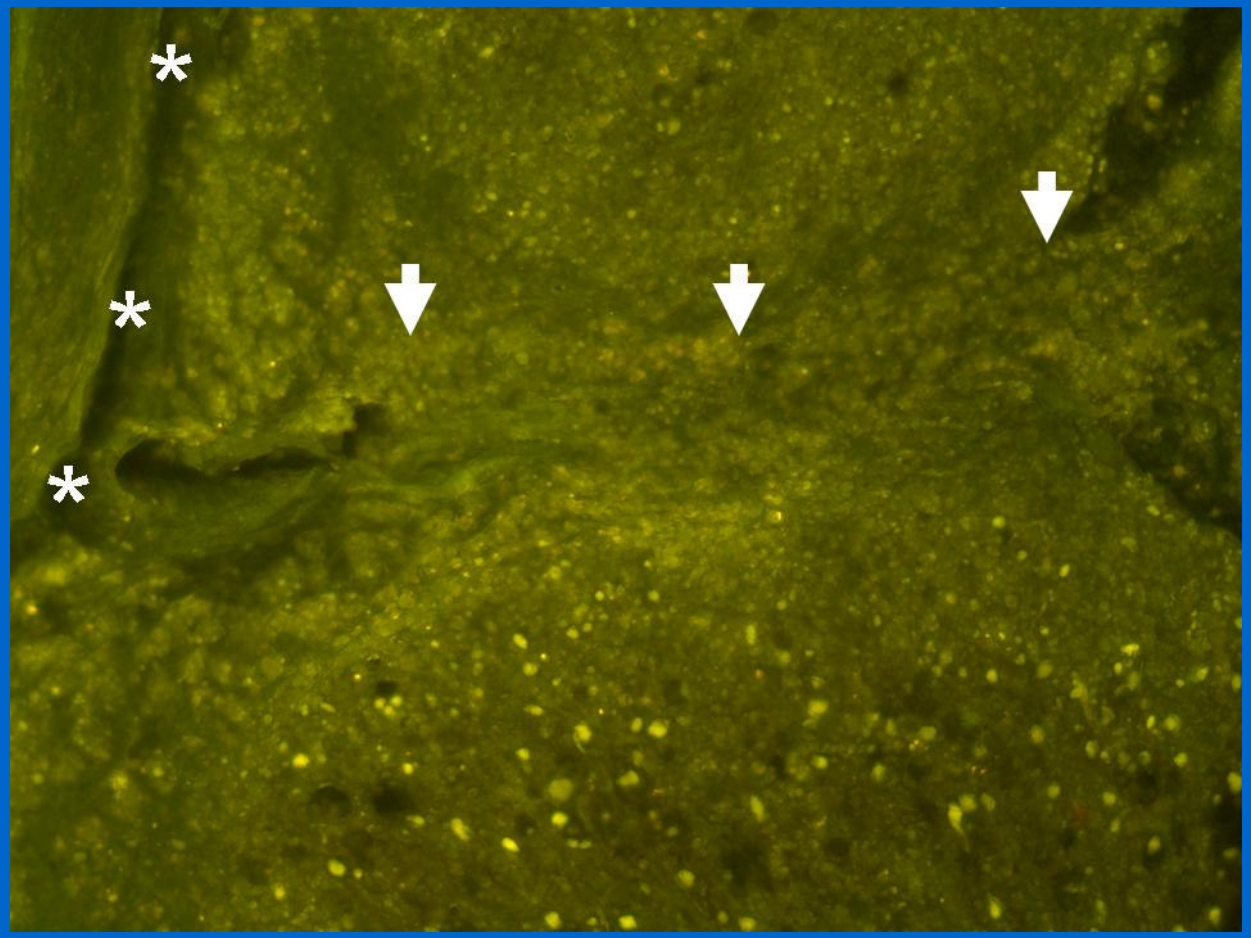


Hemi section
The gap is 1.5mm

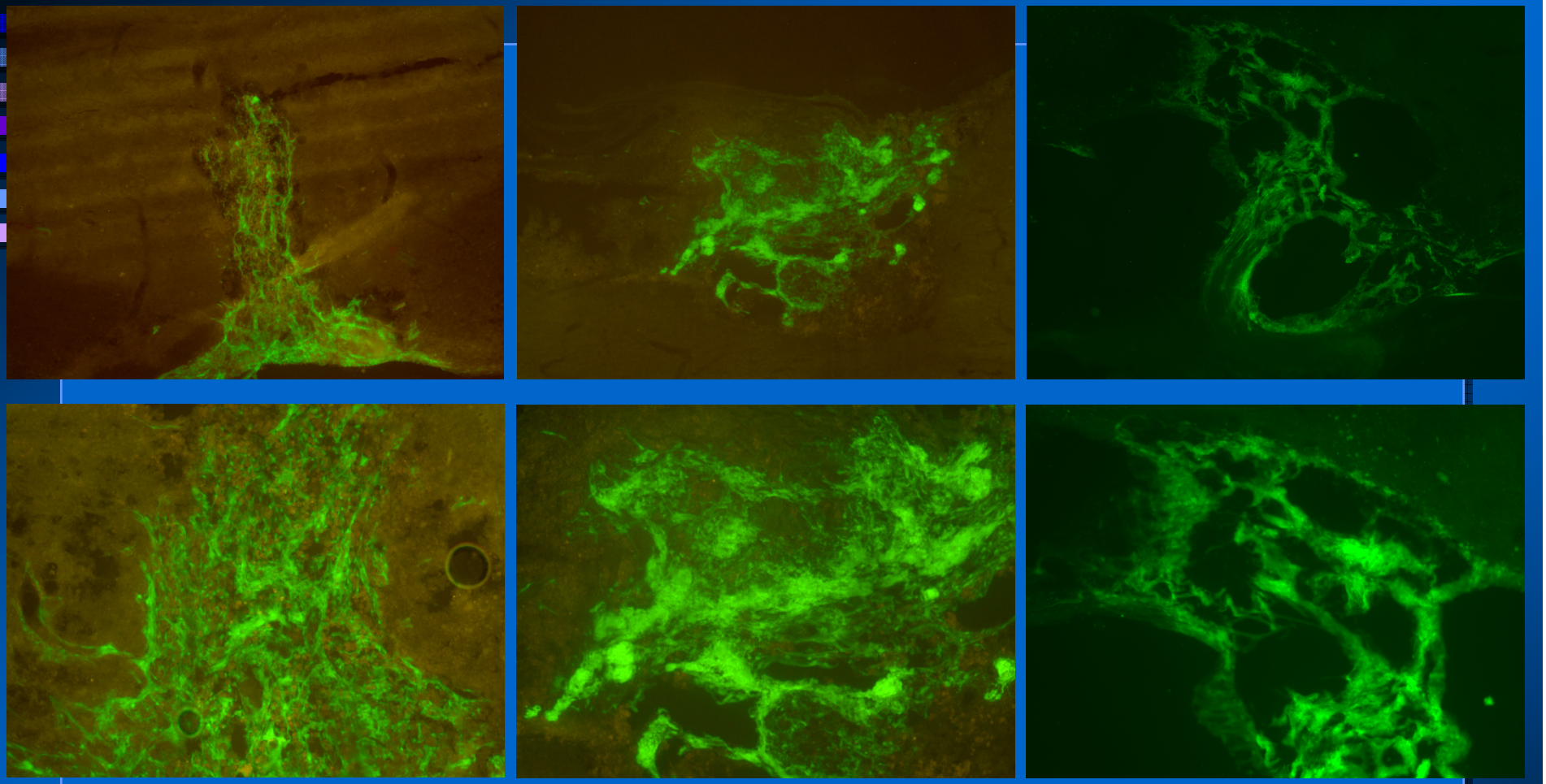
Mixture of NHS-1 in the cavity of hemi section

Guo, J., H. Su, Y. Zeng, Y.-X. Liang, R. G. Ellis-Behnke, K.-F. So, and W. Wu. Re-knitting the injured spinal cord using a self-assembling peptide nanofiber scaffold. *Nanomedicine: Nanotechnology, Biology, and Medicine.* **3**: 311-21 (2007)

Spinal healing

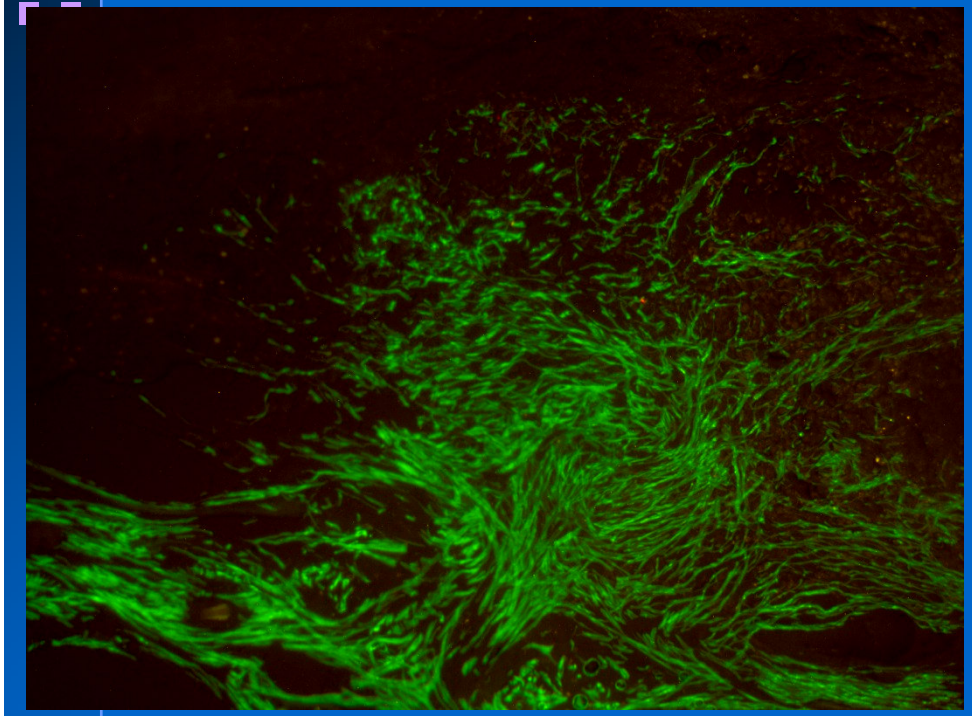


Can we add cells?

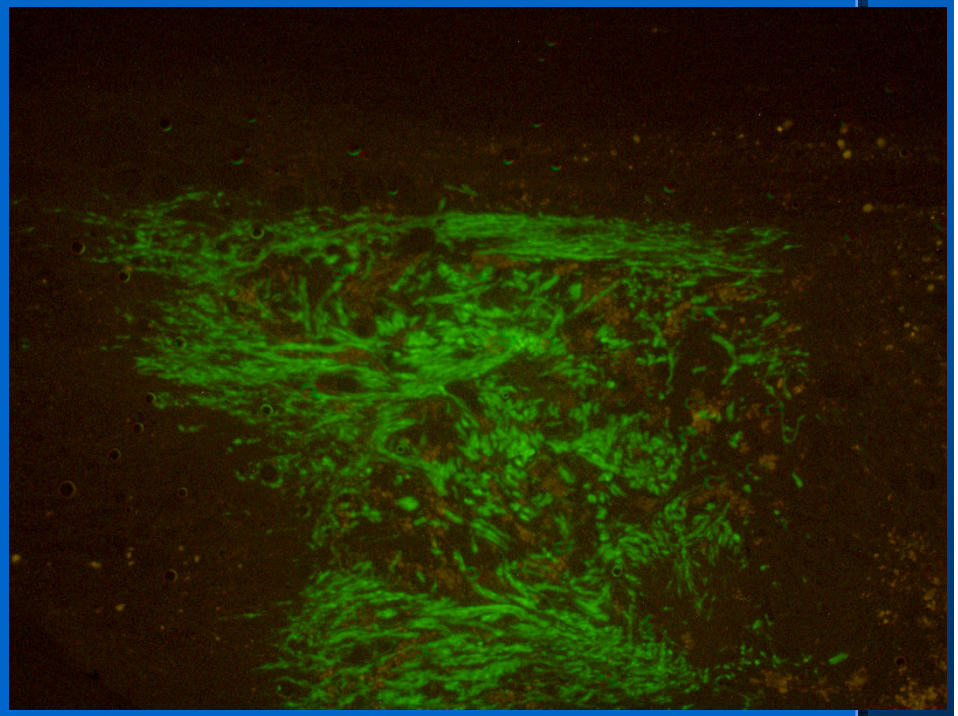


1 week 4 weeks 8 weeks

TM+NPCs groups

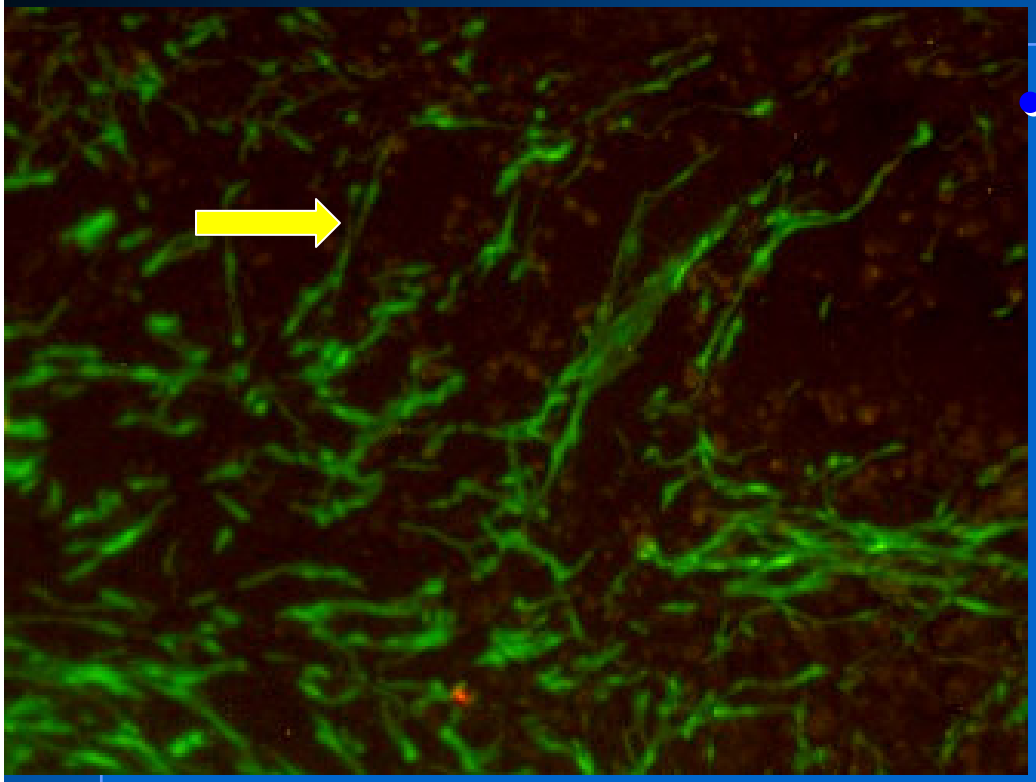


2 weeks



8 weeks

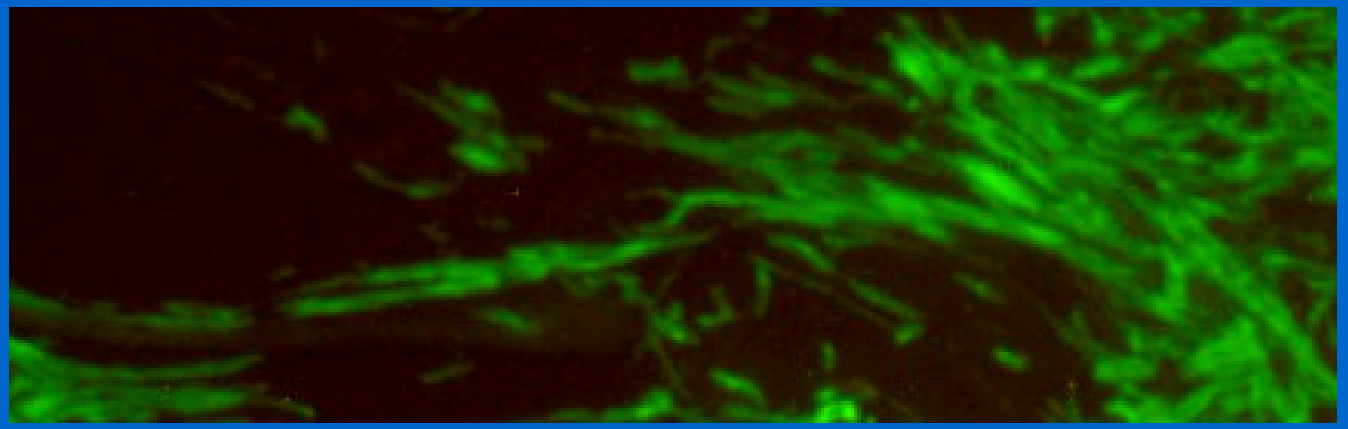
TM with NPC --GFP cells in spinal cord



- Neurons growing in environments with different modulii

Growing in tissue

Growing in Dense tissue



Is controlling regeneration the same as controlling aging?

Will this work for cancer?

- ***Using self-assembled nanomaterials to inhibit the formation of metastatic prostate cancer stem cell colonies in vitro***

(in Press) Cell Transplantation(2010)

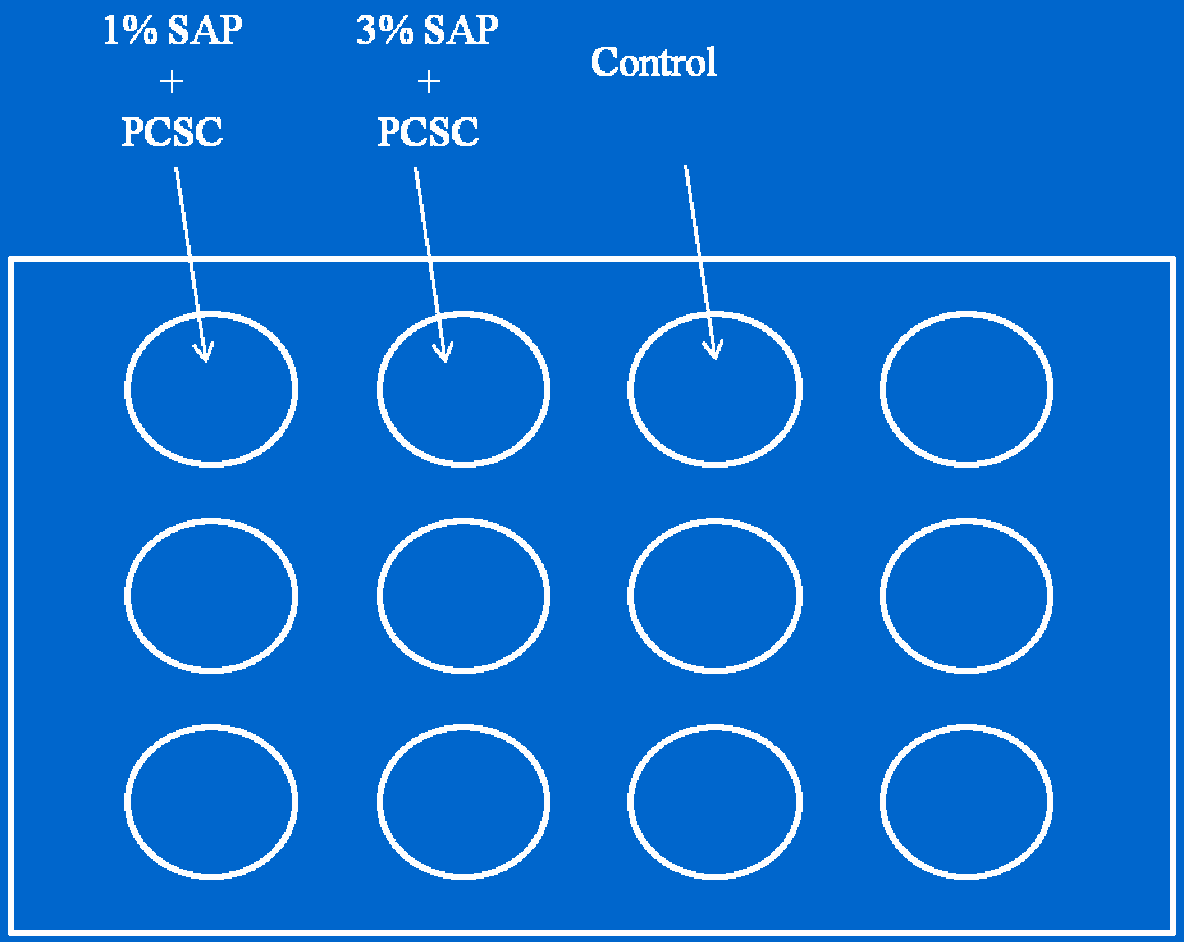
Environment engineering Prostate cancer stem cells

- Can we restrain the development?
- Can we block the movement away from the tumor?
- Chemotherapy: are we treating the Prostate Cancer Stem Cell (PCSC)
- Will the modulus be different in a tumor?

In vitro assay

- Prostate cancer stem cells
- Self assembled material (RADA)4
- prostate cancer cells (DU145, ATCC) 400 cells per 1µl
- Implanted into the material

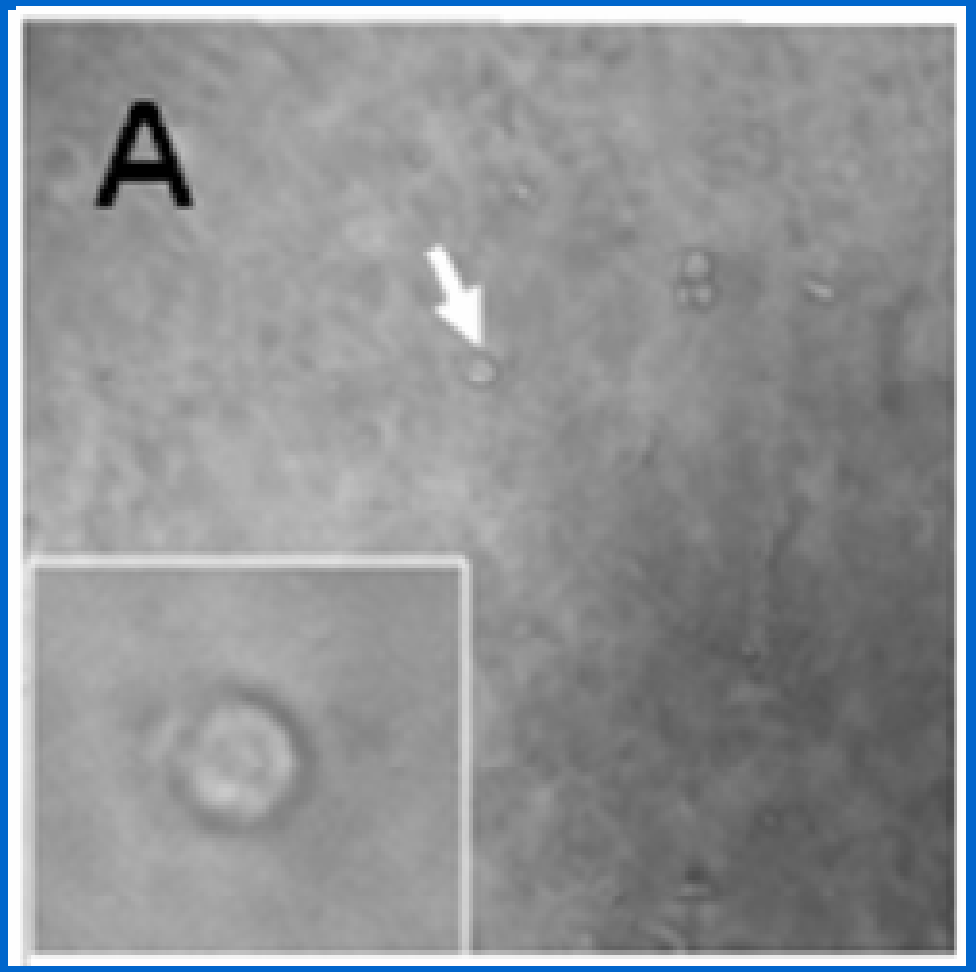
Preparation of the culture plate



Prostate cancer stem cells (PCSC) in culture and nanomaterial

Day 1
The inset has an enlarged cell

Indicated by the arrow



Cell growth and proliferation

1%

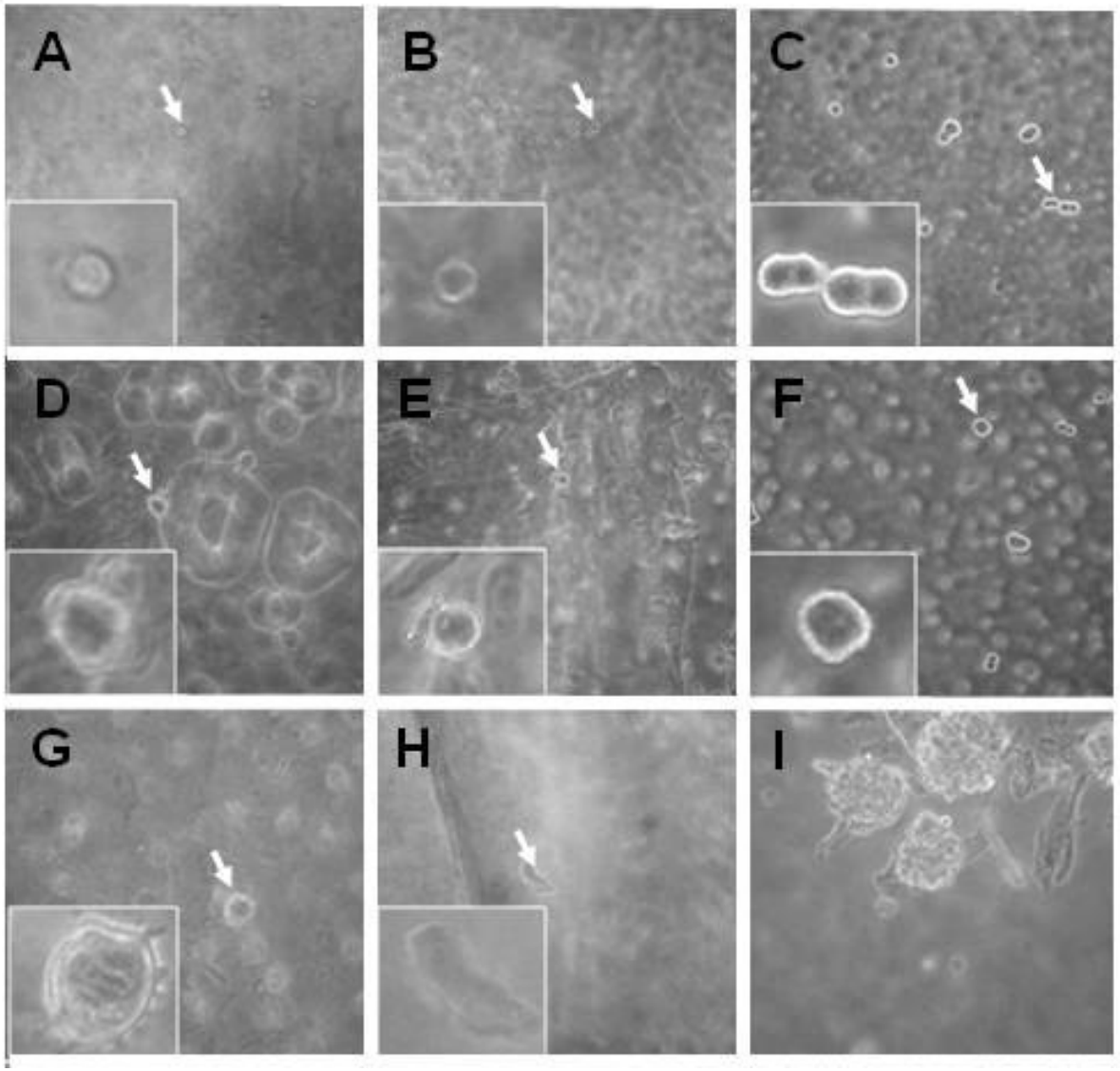
3%

Control

Day 1

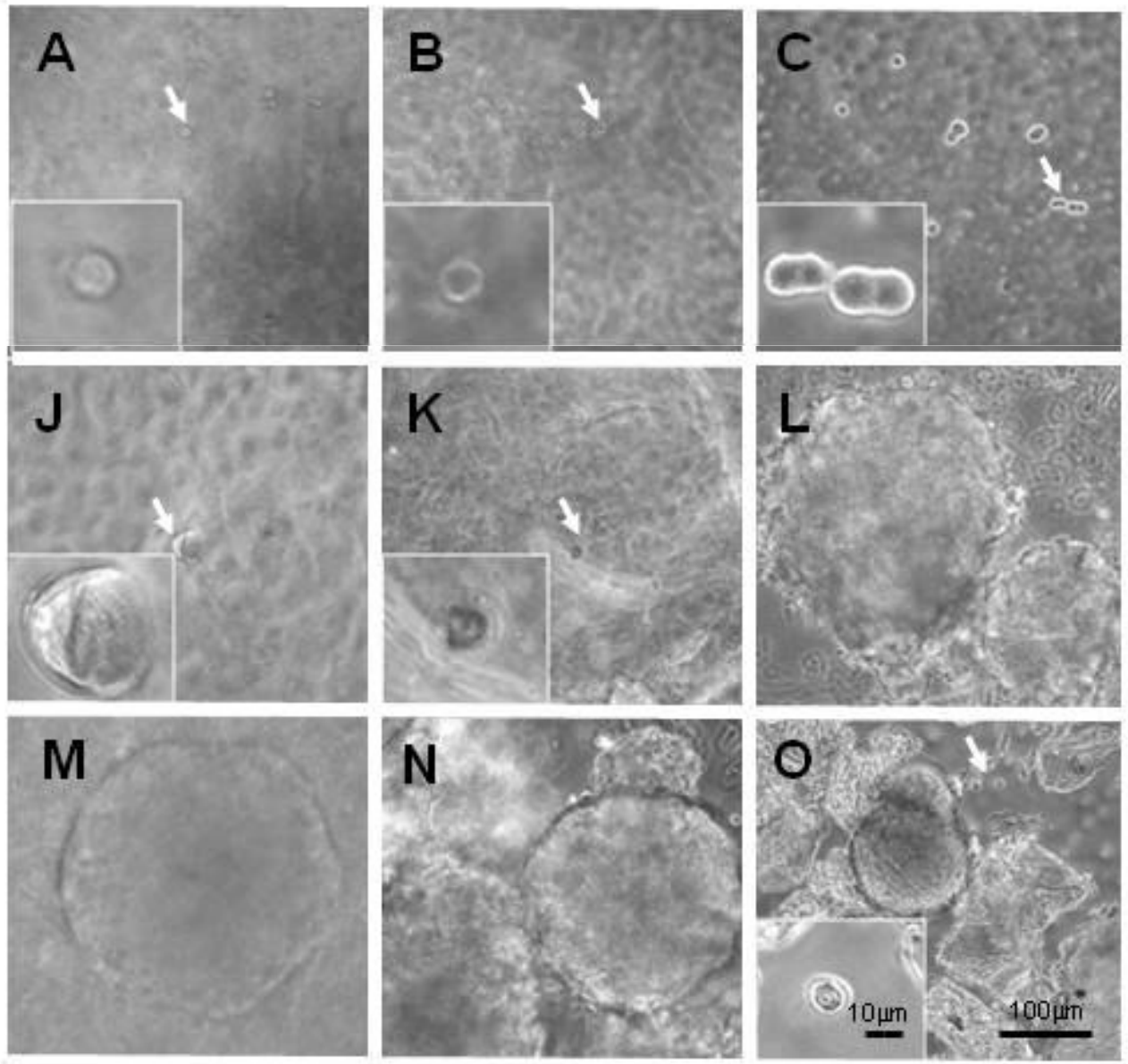
Day 4

Day 10



Cell growth and proliferation

	1%	3%	Control
Day 1	A	B	C
Day 22	J	K	L
Day 22 washed out	M	N	O

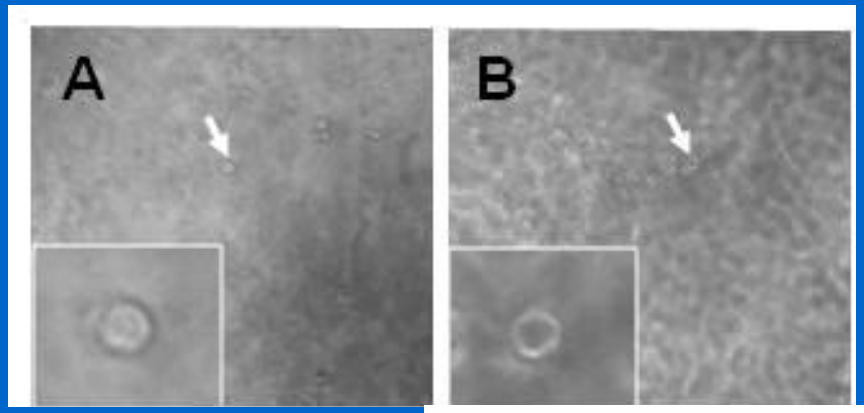


Cell growth and proliferation

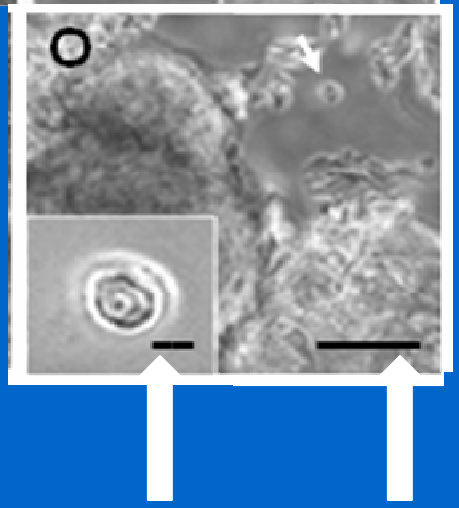
1%

3%

Day 1



Day 28
With both cells in and out of the SAP



Scale bars 5 10 microns

Can we treat slow growing cancers like this?

- Injecting the material directly into the tumor
- It might be possible to stop the spread of metastatic cells before or during resection.
- Load SAP with chemotherapeutic agents
- The localized treatment could potentially be increased due to the increased contact time.

Biopsy metastases

- In breast biopsy there are cells found in the fine needle biopsy track
- Could we use some of these materials to stop this ?

Intersection of nanotechnology and healthcare

- Molecular manipulation
  - Nanomaterials are delivered as specific and deliberate molecular structures
  - Delivered directly to the site
  - Require a much smaller dose

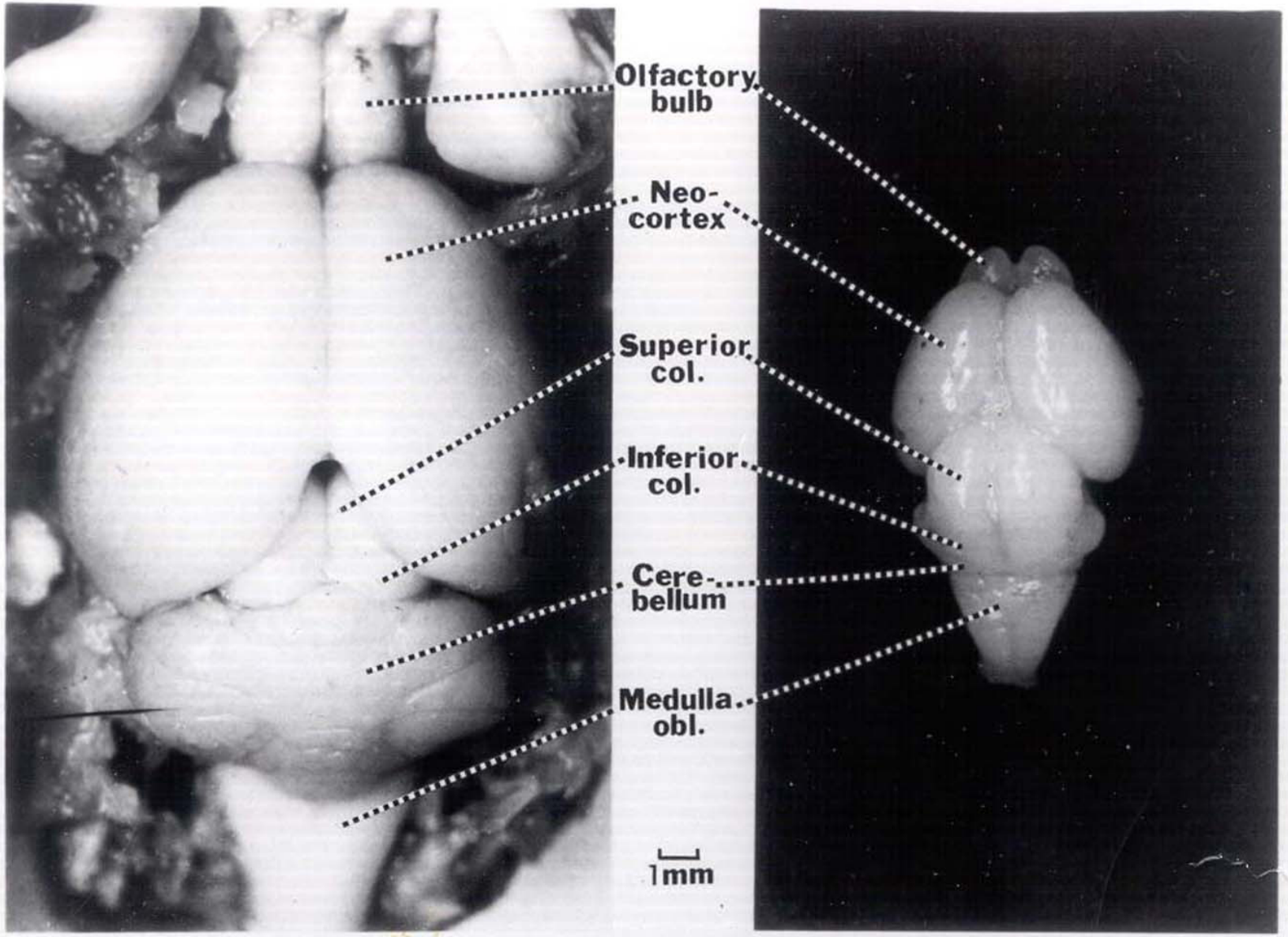
Nano Neuro Knitting peptide nanofiber scaffold (SAPNS) for brain repair and axon regeneration with functional return of vision: *In-vivo* experiment on developing brain and adult mammals

Ellis-Behnke, R. G., Y.-X. Liang, S.-W. You, D. K. C. Tay, S. Zhang, K.-F. So and G. E. Schneider. Nano neuro knitting: peptide nanofiber scaffold for brain repair and axon regeneration with functional return of vision, *Proc Nat Acad Sci U S A*. 103: 5054-5059 (2006)

- *In vivo* experiments
  - Developing brain P(3)
  - Adult mammals

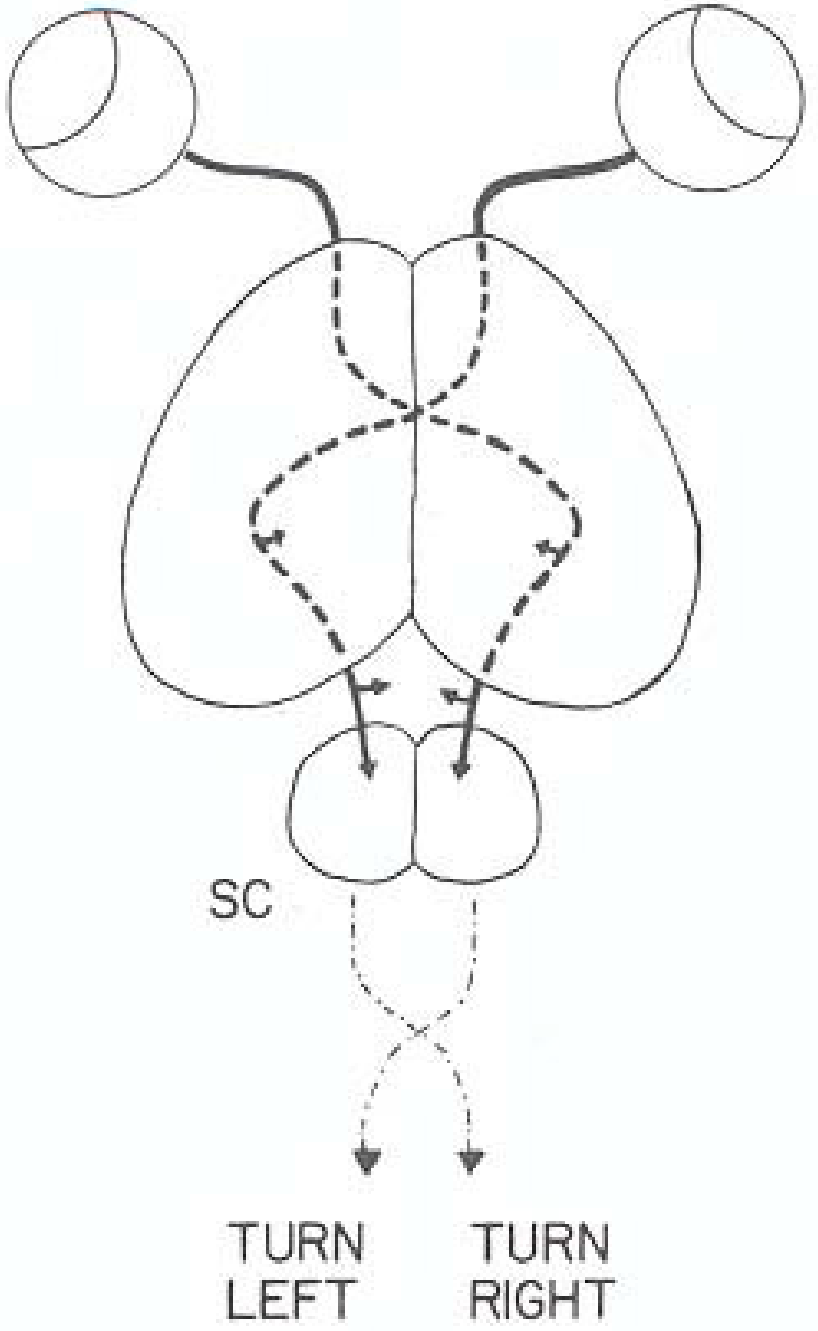
Adult and P0 Hamster Brains

Schneider 73 Brain

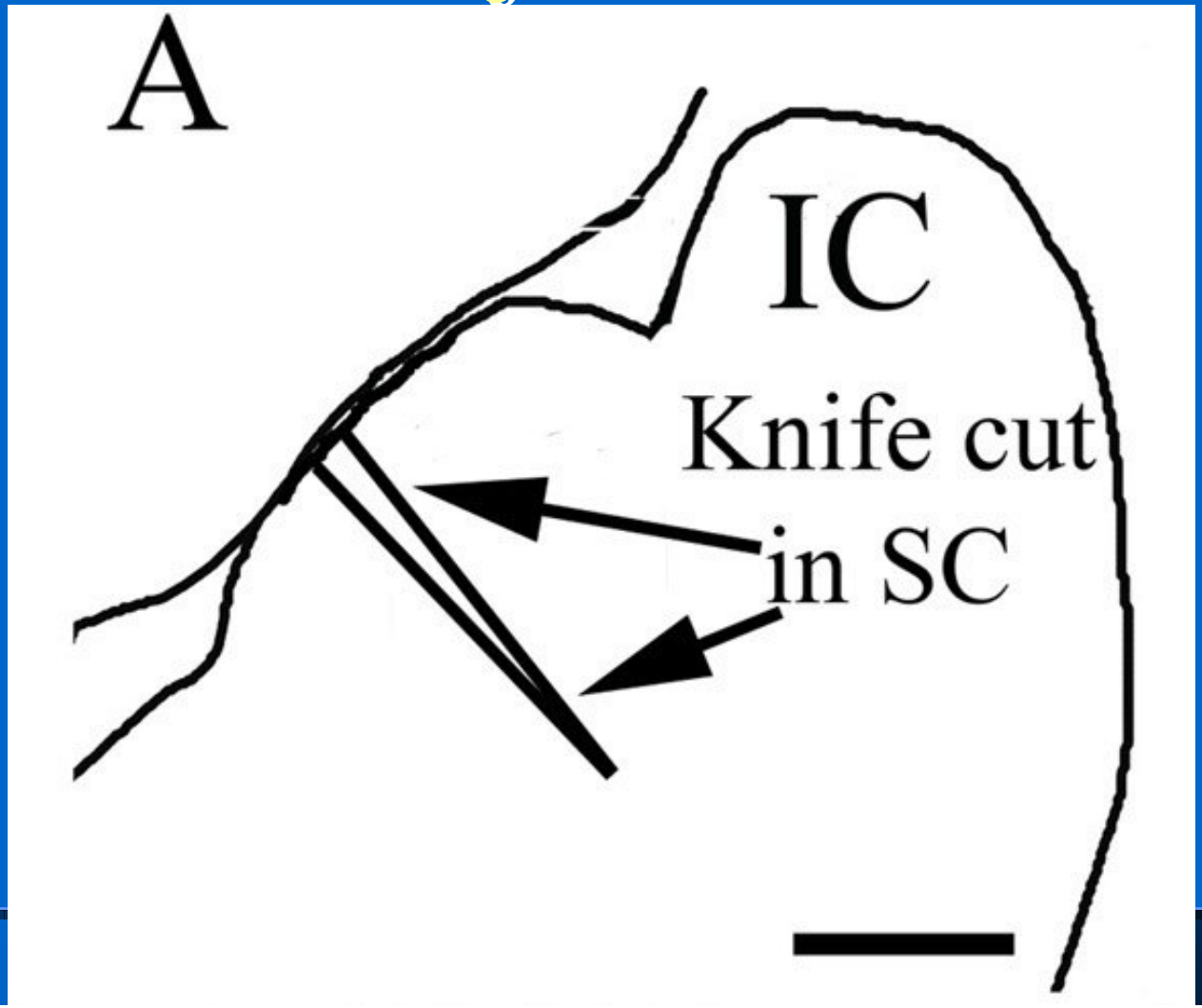


Normal Animal

Retina to Contralateral SC

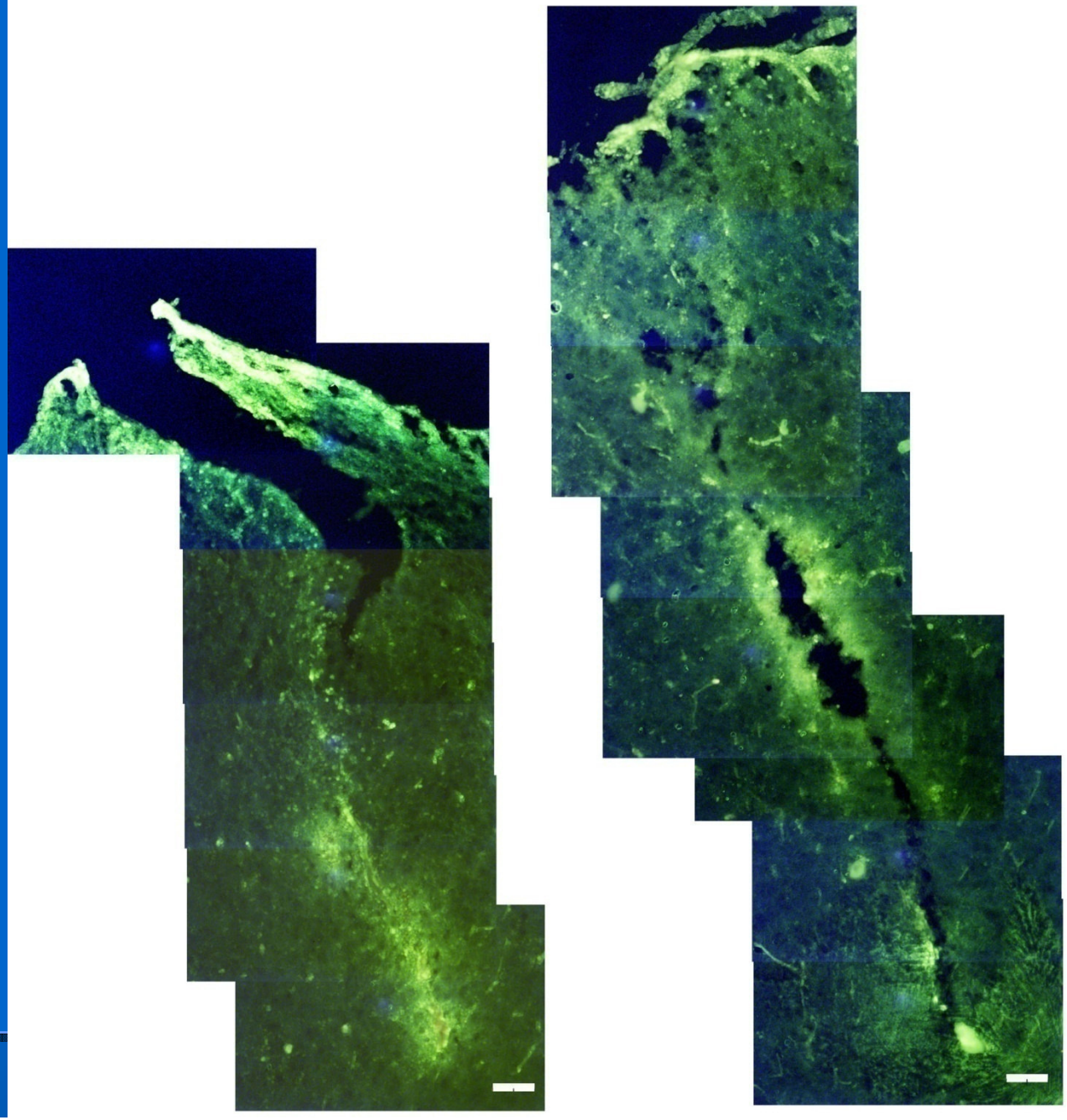


Location of surgery and SAPNS injection



Control (left)

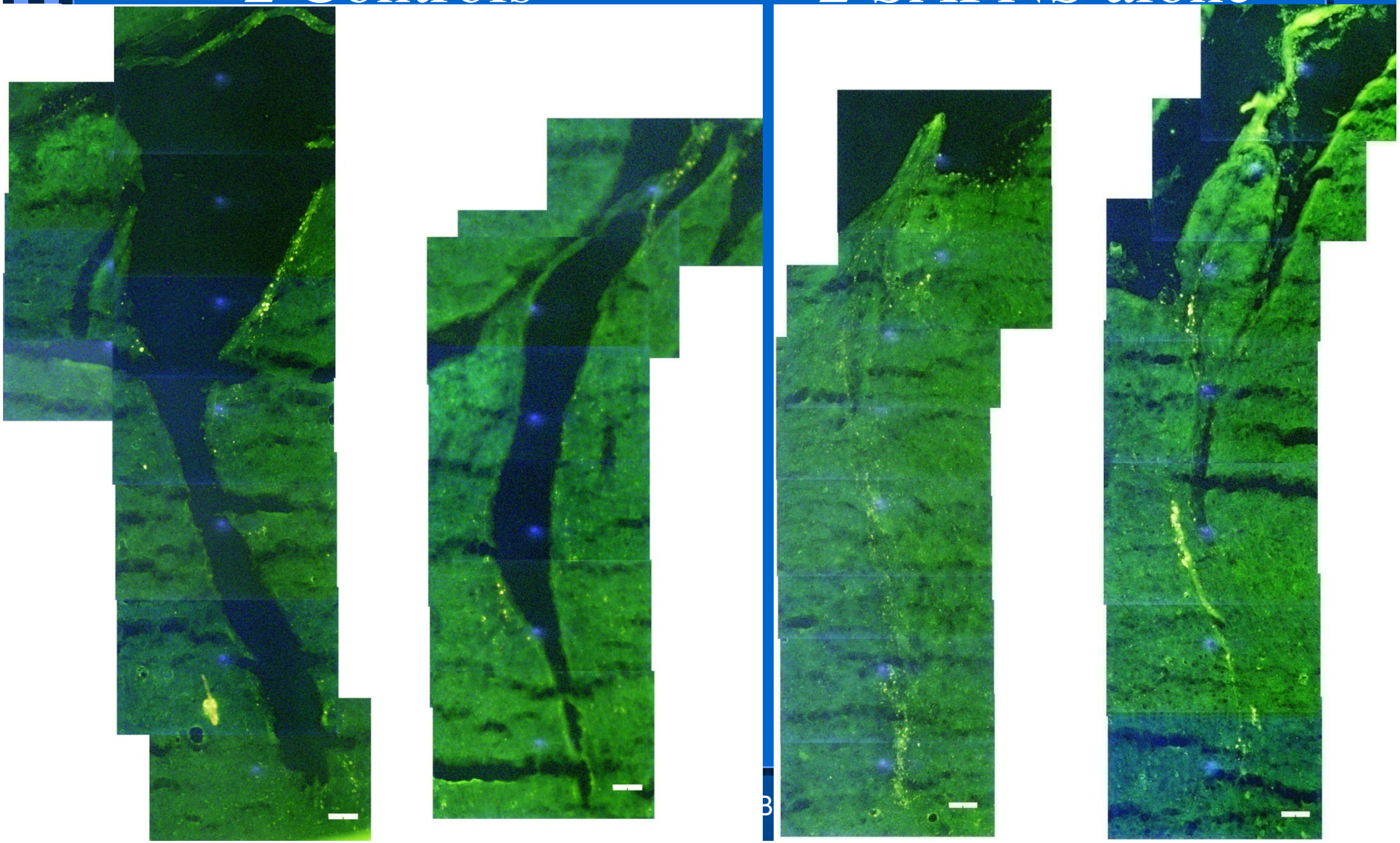
SAPNS alone (right) 24 hrs



1 month post lesion

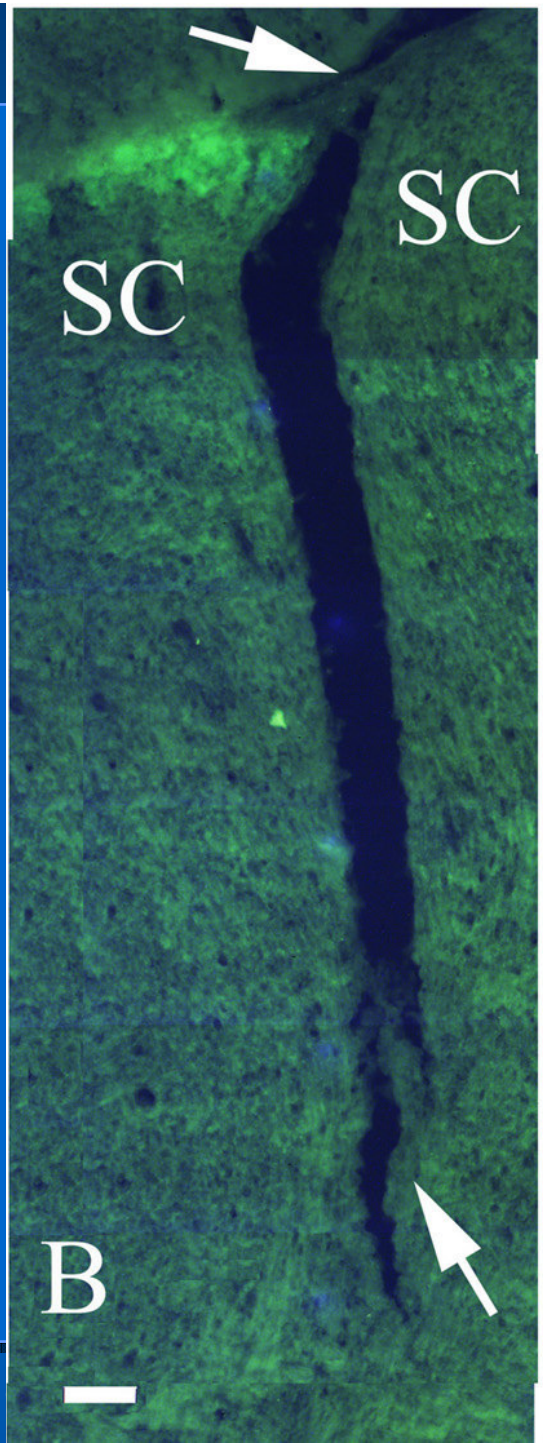
2 Controls

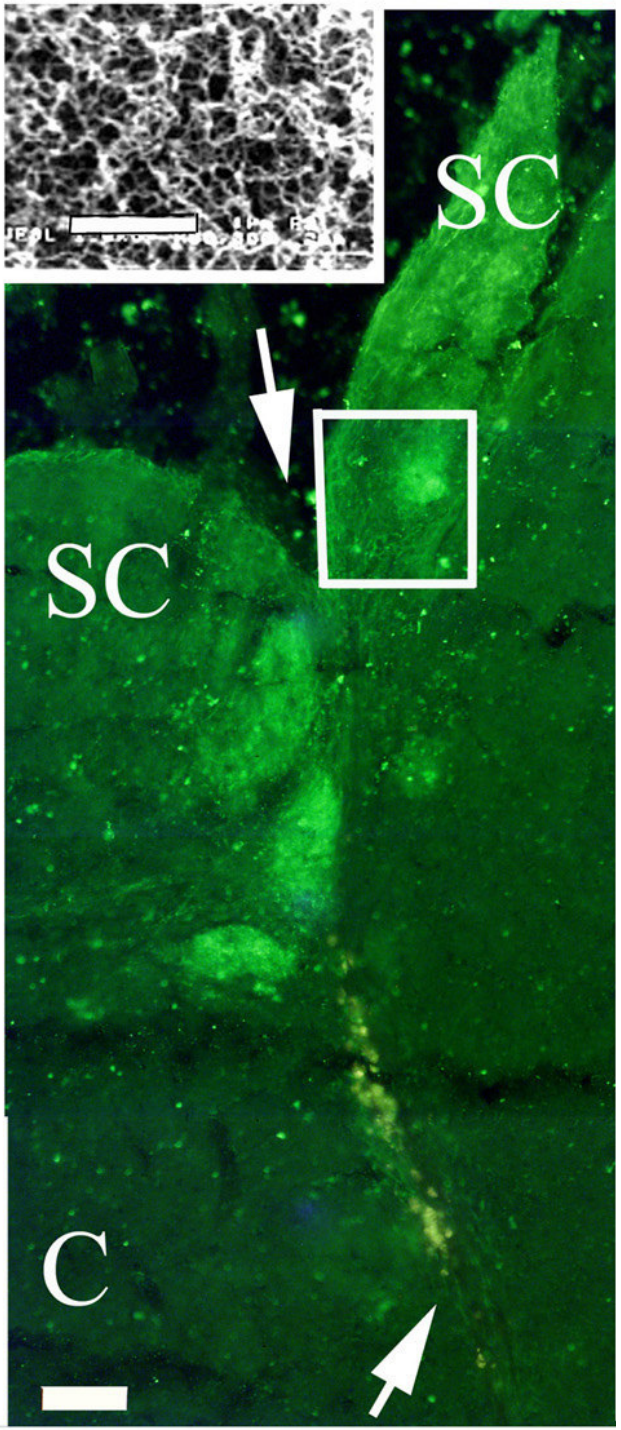
2 SAPNS alone



B: Saline control injection B

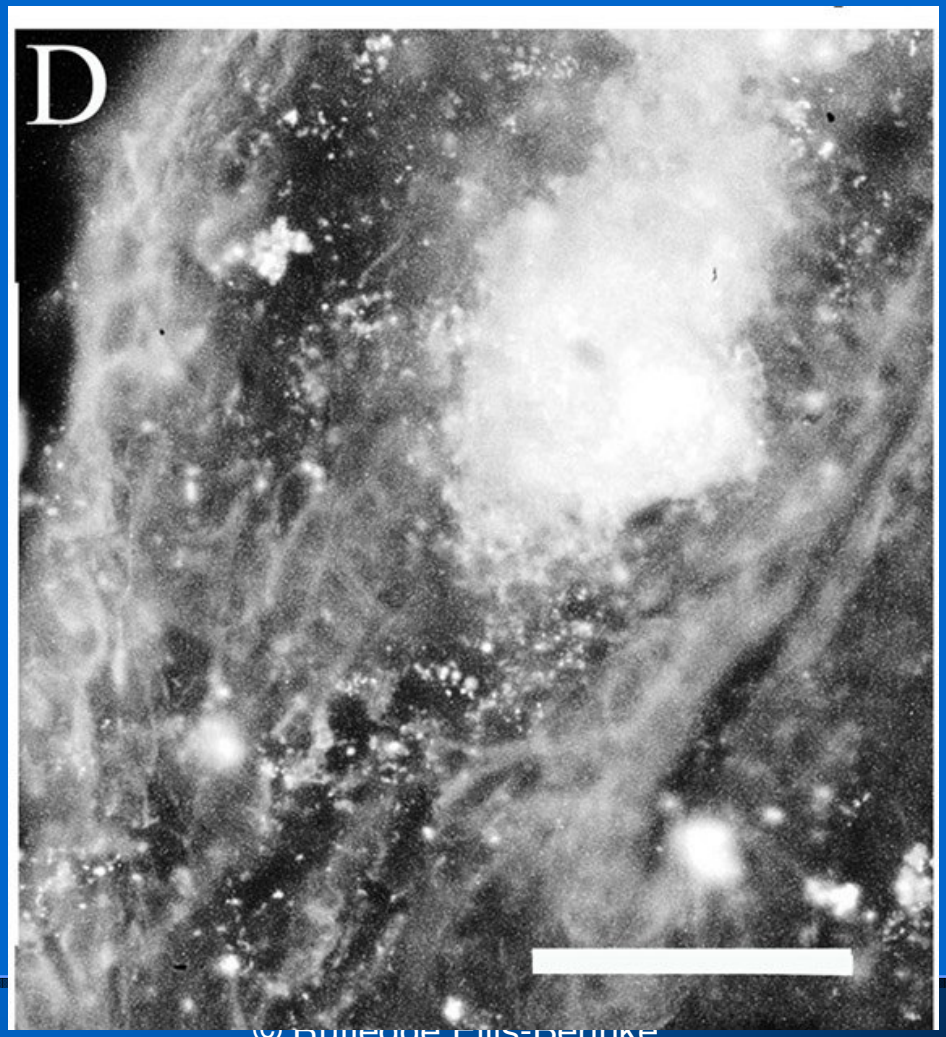
C: Repair of CNS lesion with SAPNS





Scale Bars 500 microns

Regenerated axons in area of dense termination

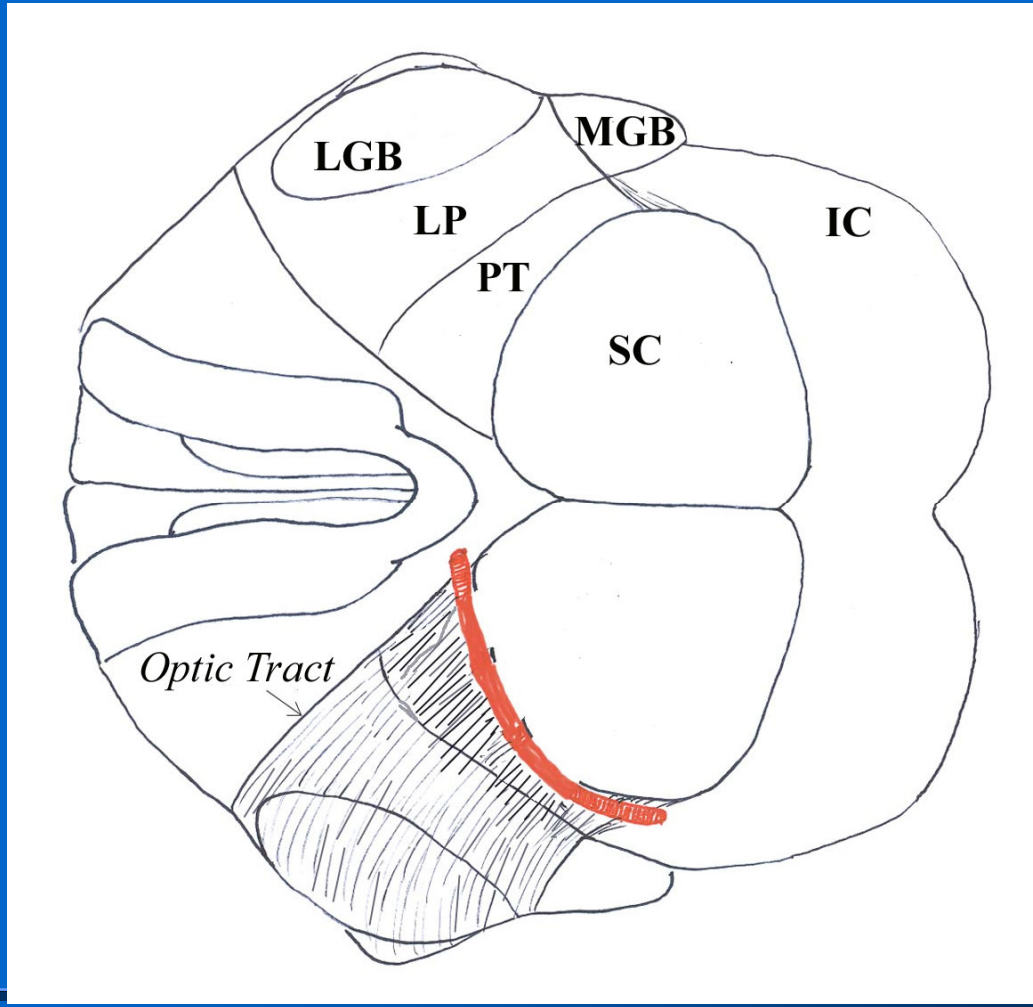


Adult Mammal

- Self-assembling peptide nano scaffold (SAPNS) treatment after complete transection of optic tract
- Behavioral testing of vision

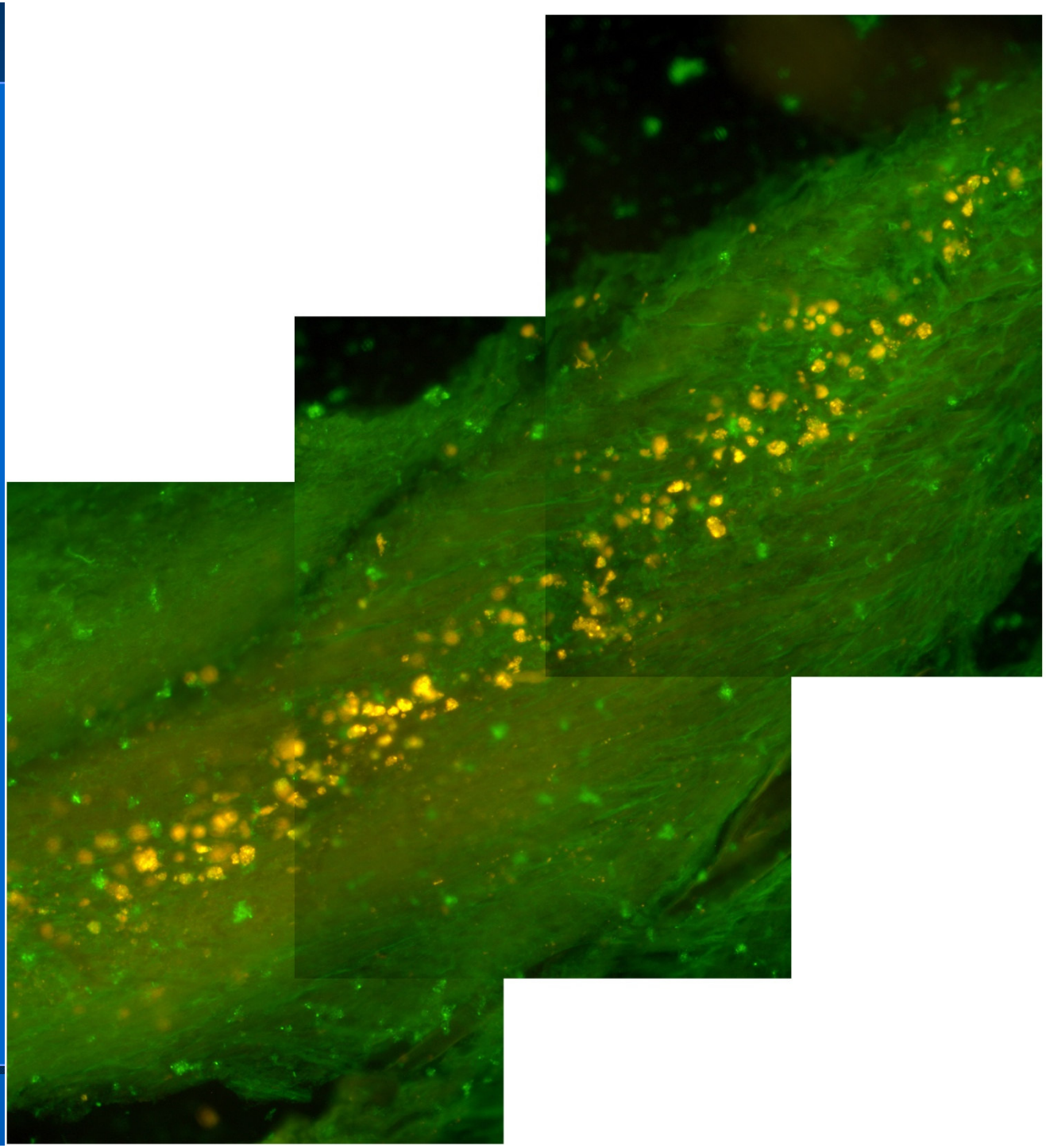
Ellis-Behnke, R. G., Y.-X. Liang, S.-W. You, D. K. C. Tay, S. Zhang, K.-F. So and G. E. Schneider. Nano neuro knitting: peptide nanofiber scaffold for brain repair and axon regeneration with functional return of vision, *Proc Nat Acad Sci U S A.* 103: 5054-5059 (2006)

Brachium Transection

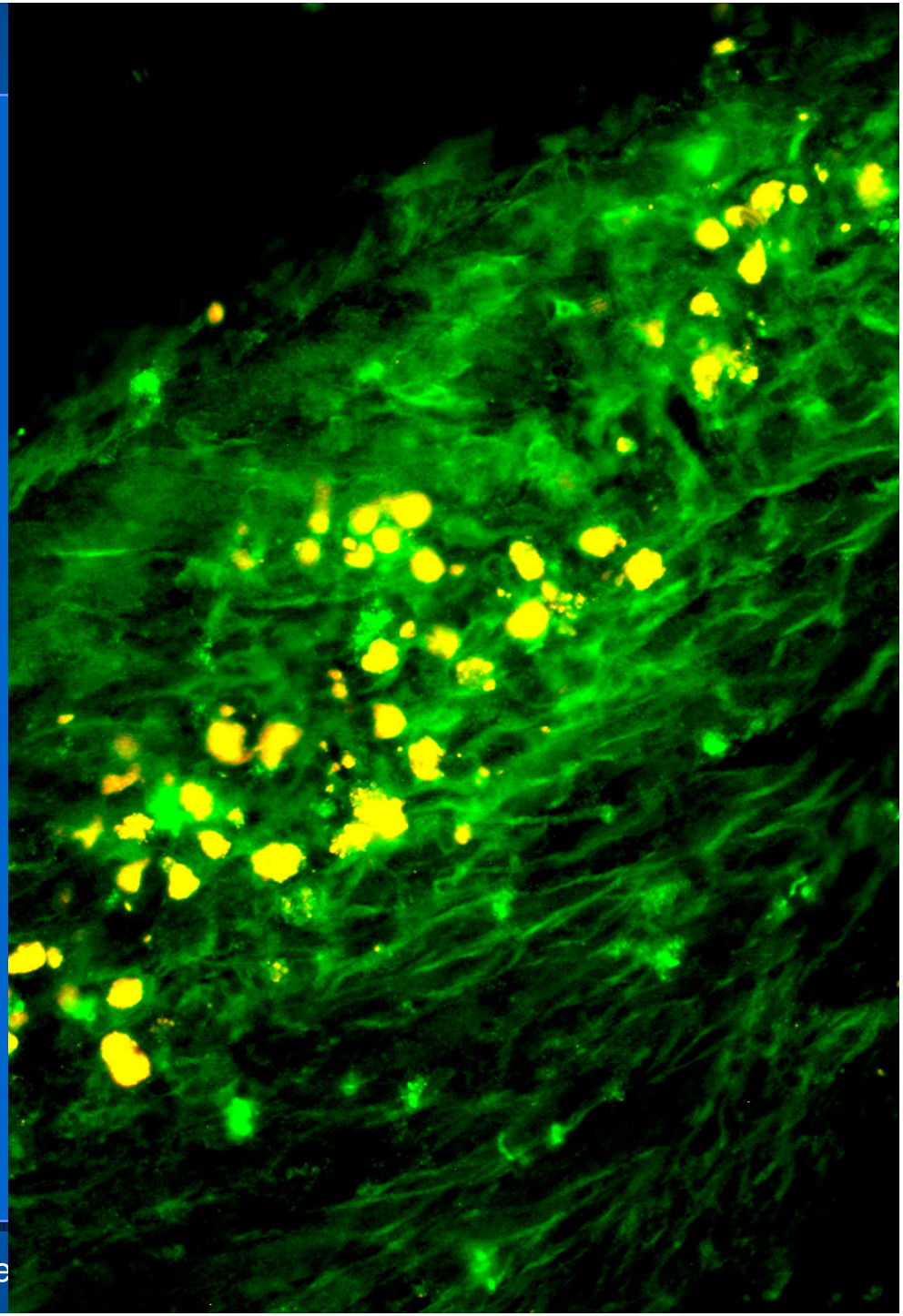


SAPNS alone after functional return of vision

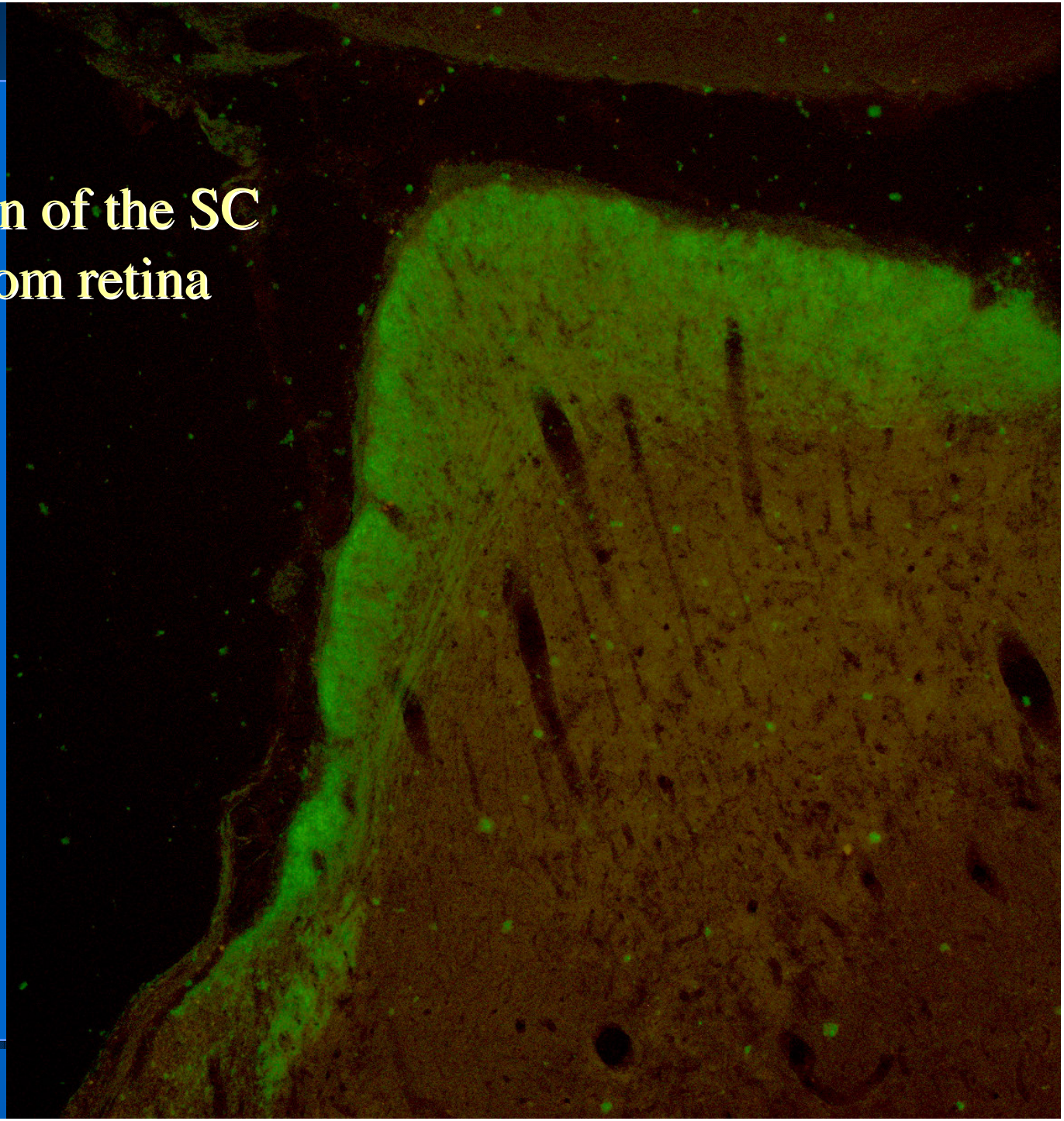
Adult animal



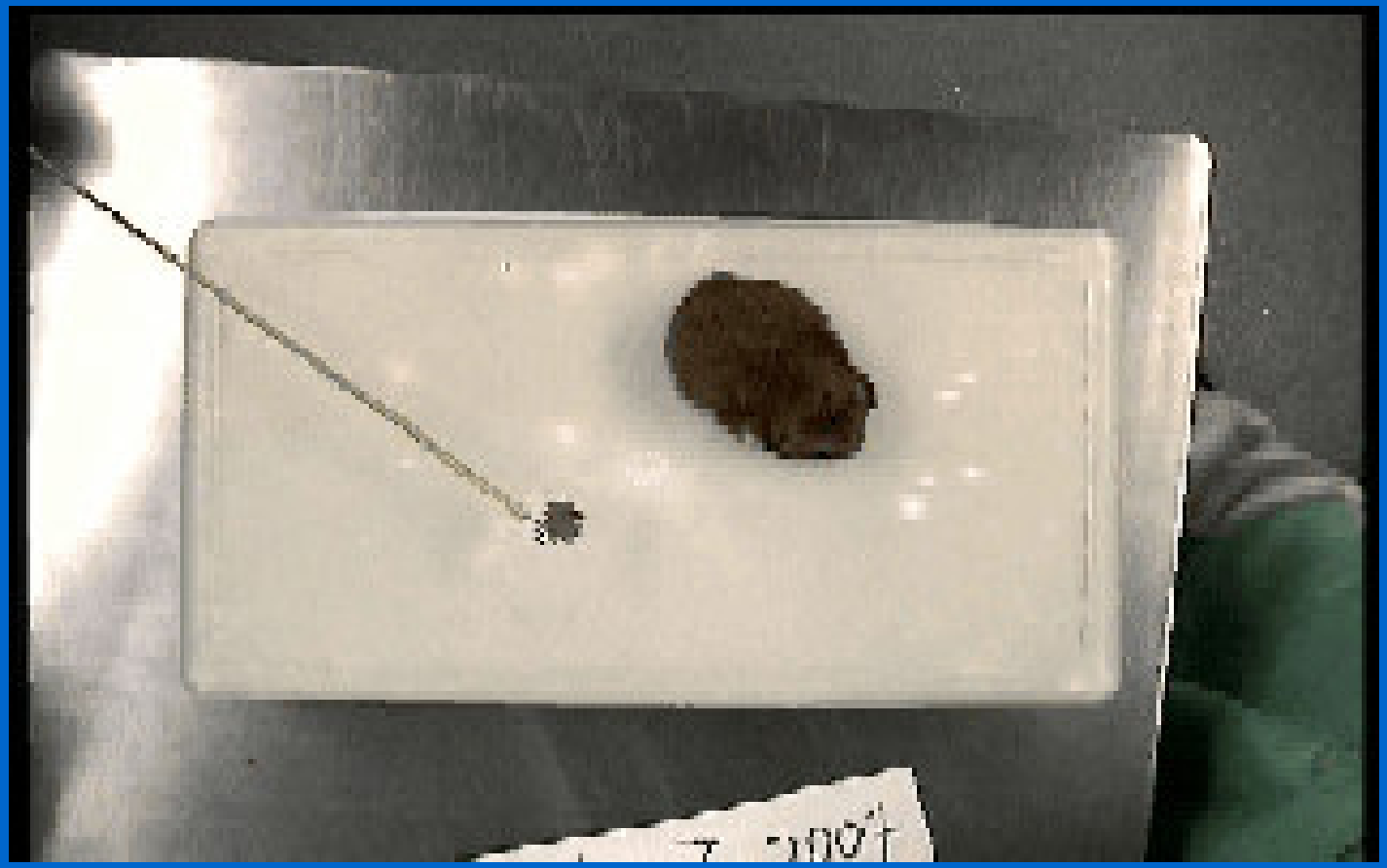
- Regenerated axons in the middle of the lesion site



Re-innervation of the SC by axons from retina



Blind Control

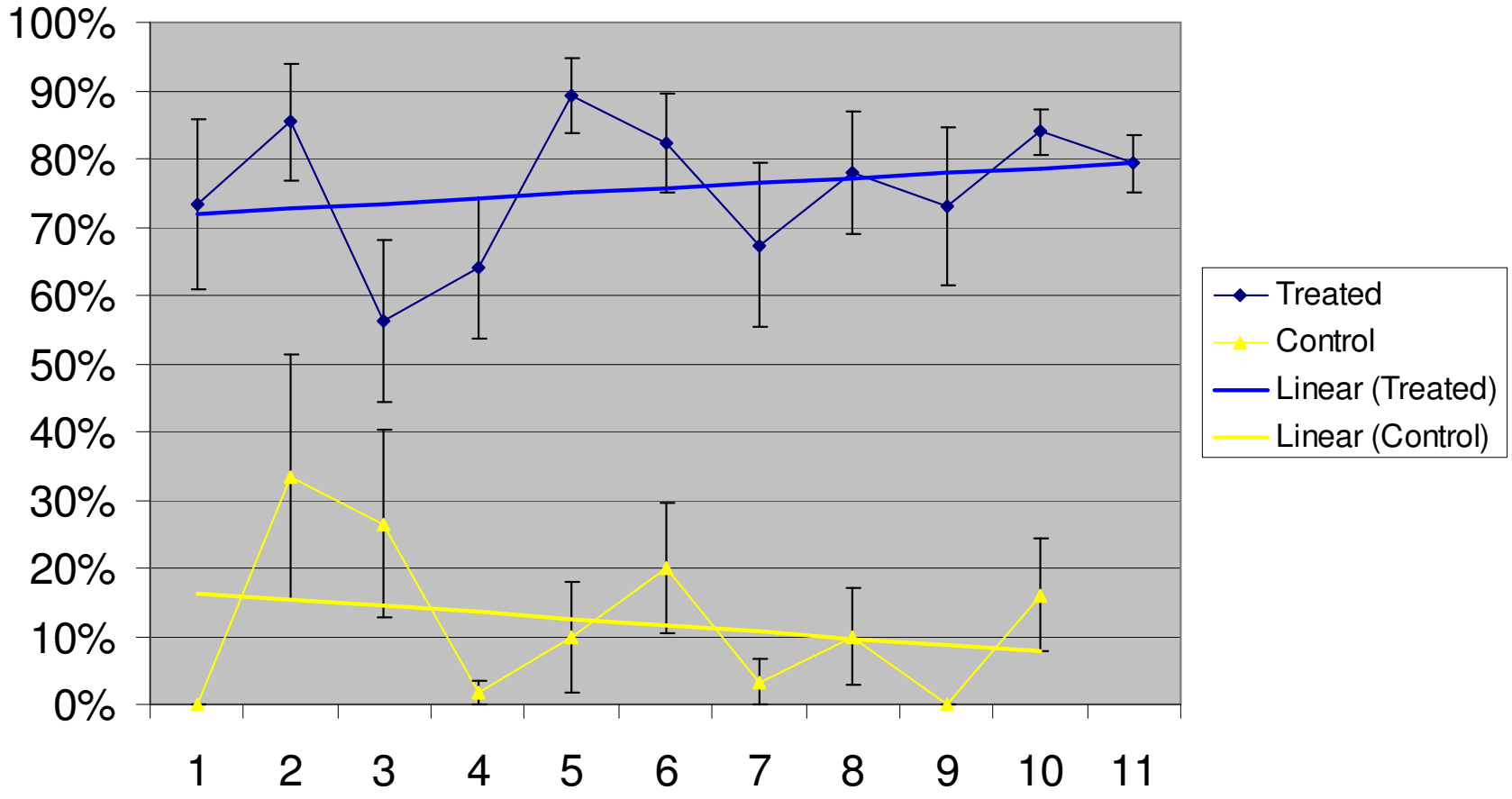


Schneider, G. E., R. G. Ellis-Behnke, Y. X. Liang, P. W. F. Kau, D. K. C. Tay, and K.-F. So. Behavioral testing and preliminary analysis of the hamster visual system. *Nature Protocols*. 1: 1898-1905 (2006)

SAPNS Brachium Bridge Functional return of vision

Schneider, G. E., R. G. Ellis-Behnke, Y. X. Liang, P. W. F. Kau, D. K. C. Tay, and K.-F. So. Behavioral testing and preliminary analysis of the hamster visual system. *Nature Protocols*. 1: 1898-1905 (2006)

Behavior Recovery
Treated vs. Control



EM Pictures with 2 % SAPNS in cortex Time 5 minutes

CNS Summary

- Reduces the cavitation at site of injury
- Treatments allow the tissue to construct bridging tissue
- The time for healing starts in the first 24 hours
- Axons regenerate across the lesion site
- Breakdown products of SAPNS can become building blocks for repair
- Functional return of vision is enabled

Intersection of nanotechnology and healthcare

- Rethinking tissue engineering
  - Ability to influence an environment
  - Additive
  - Arrestive
  - Manipulative

In vivo monitoring of CNS regeneration

Slow progression toward recovery

CNS regeneration after chronic injury using a self-assembled nano material and MEMRI for real time in vivo monitoring

(under review)

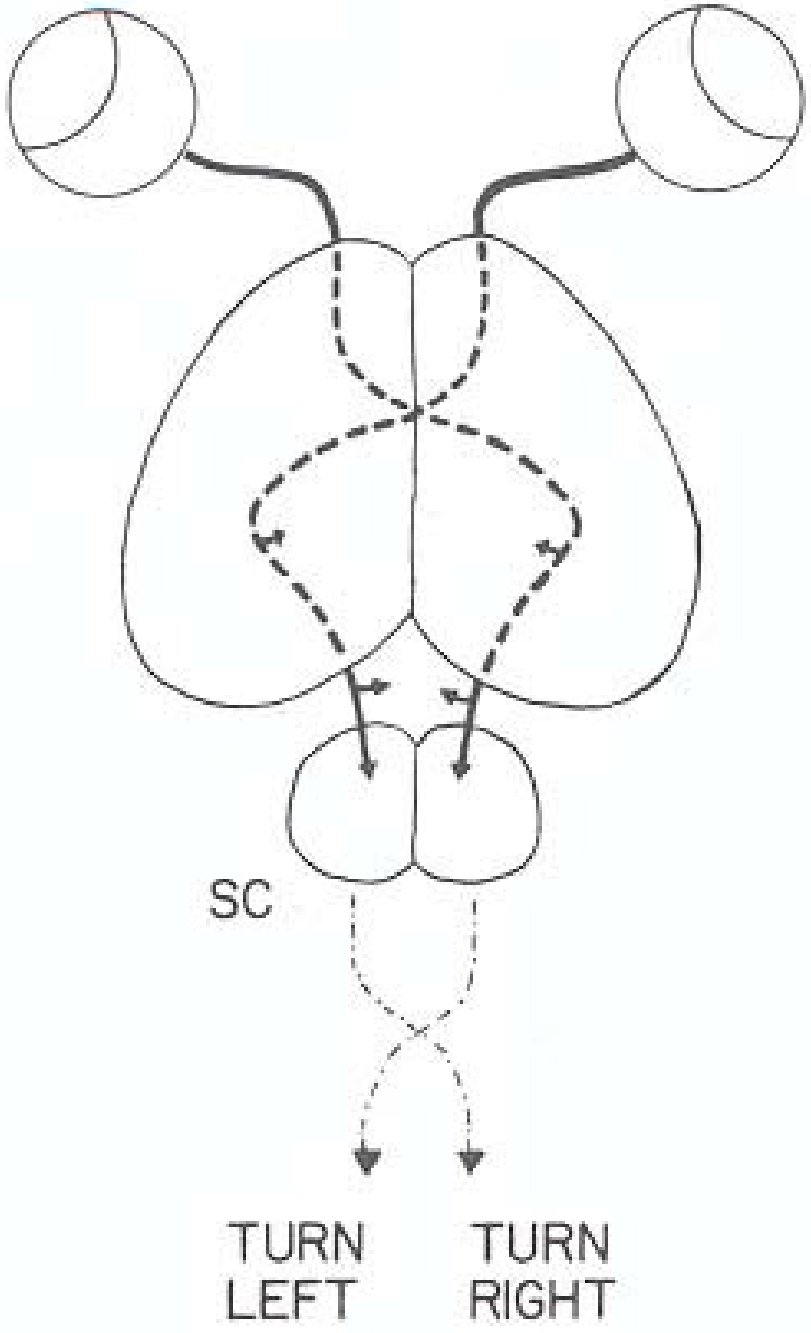
Nano
Contrast enhancement agents

- *In vivo* imaging
- To follow regeneration as it happens

7 T MRI
Hong Kong University

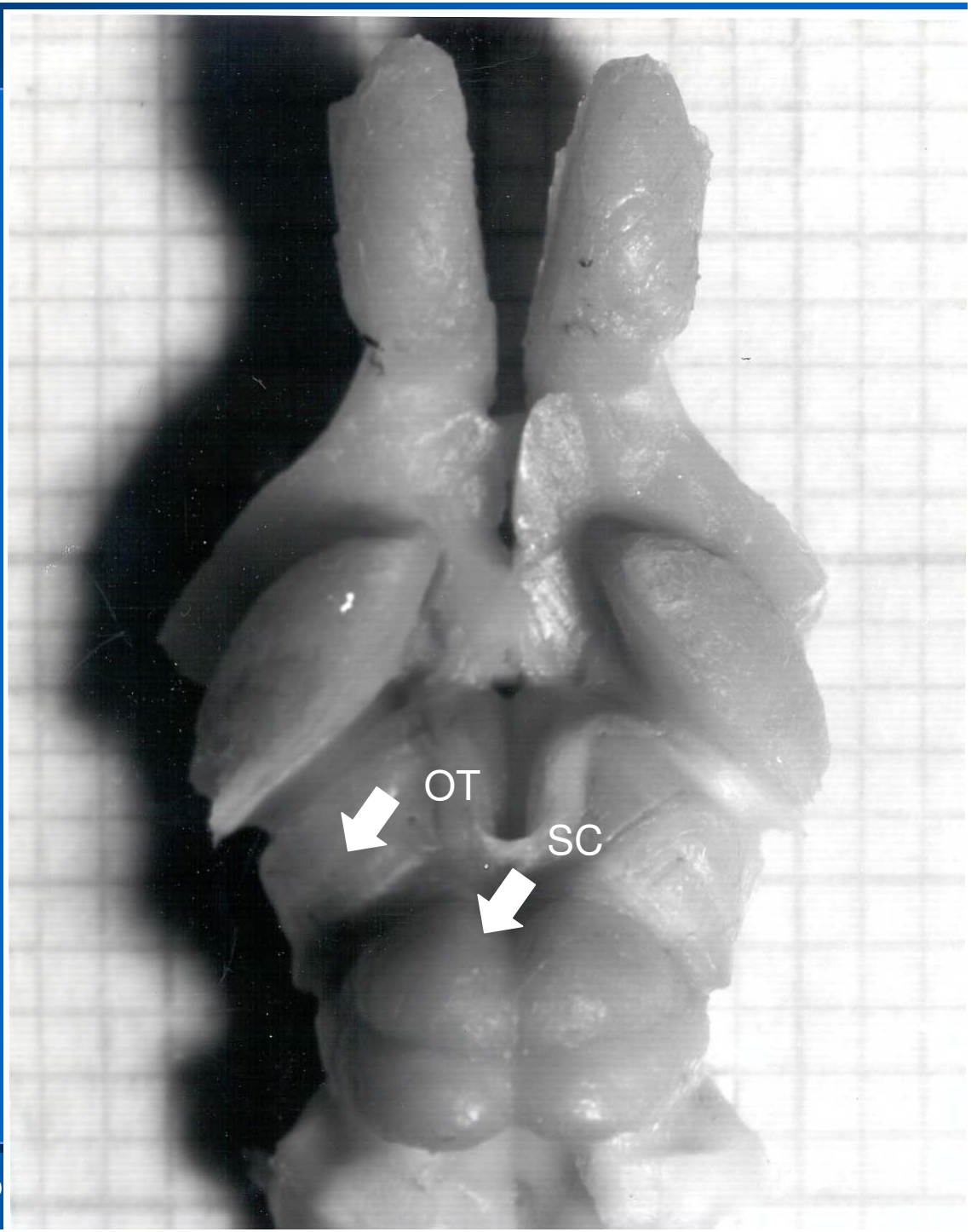
Normal Animal

Retina to Contralateral SC

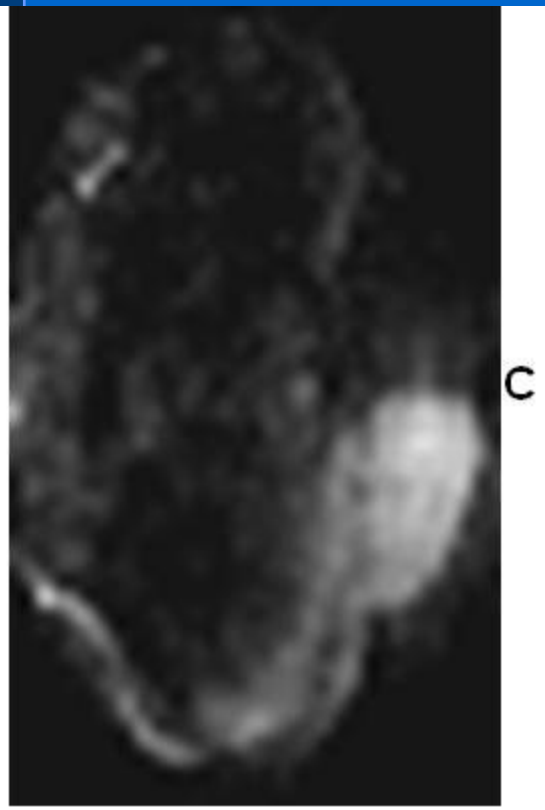


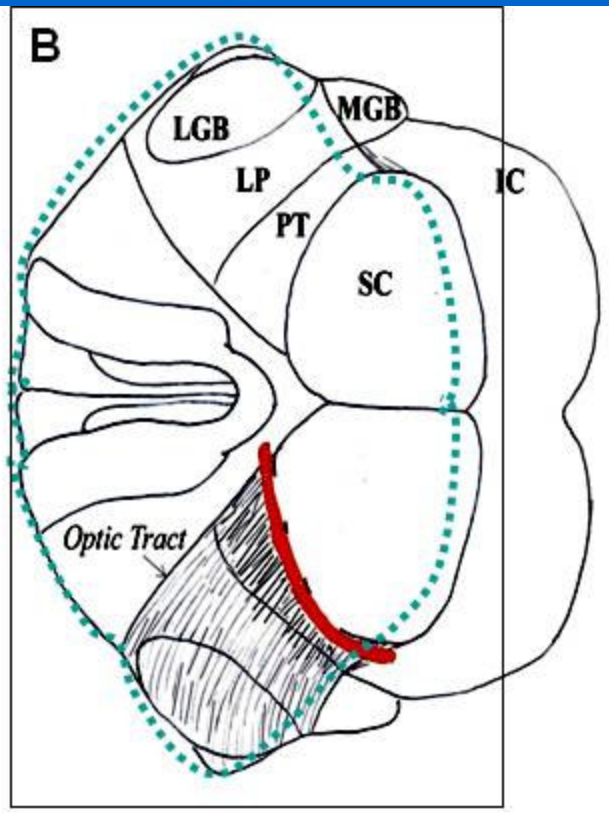
Hamster Brain with the cortex removed

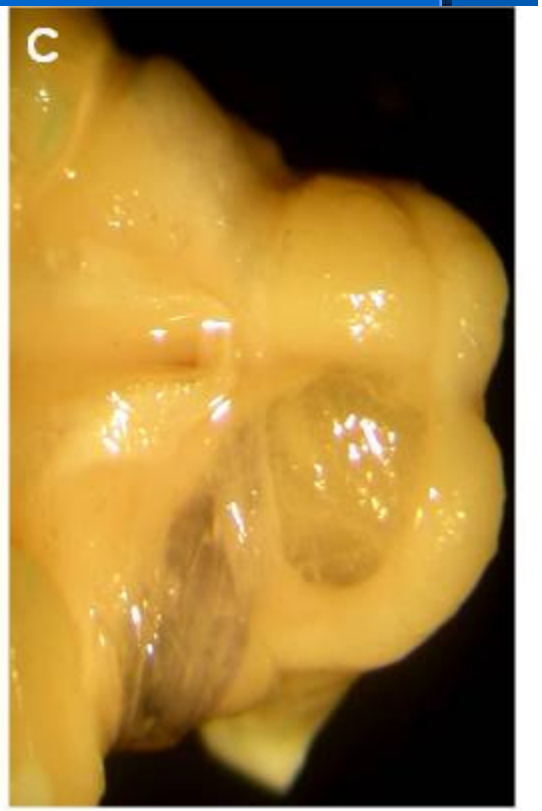
1 mm grid

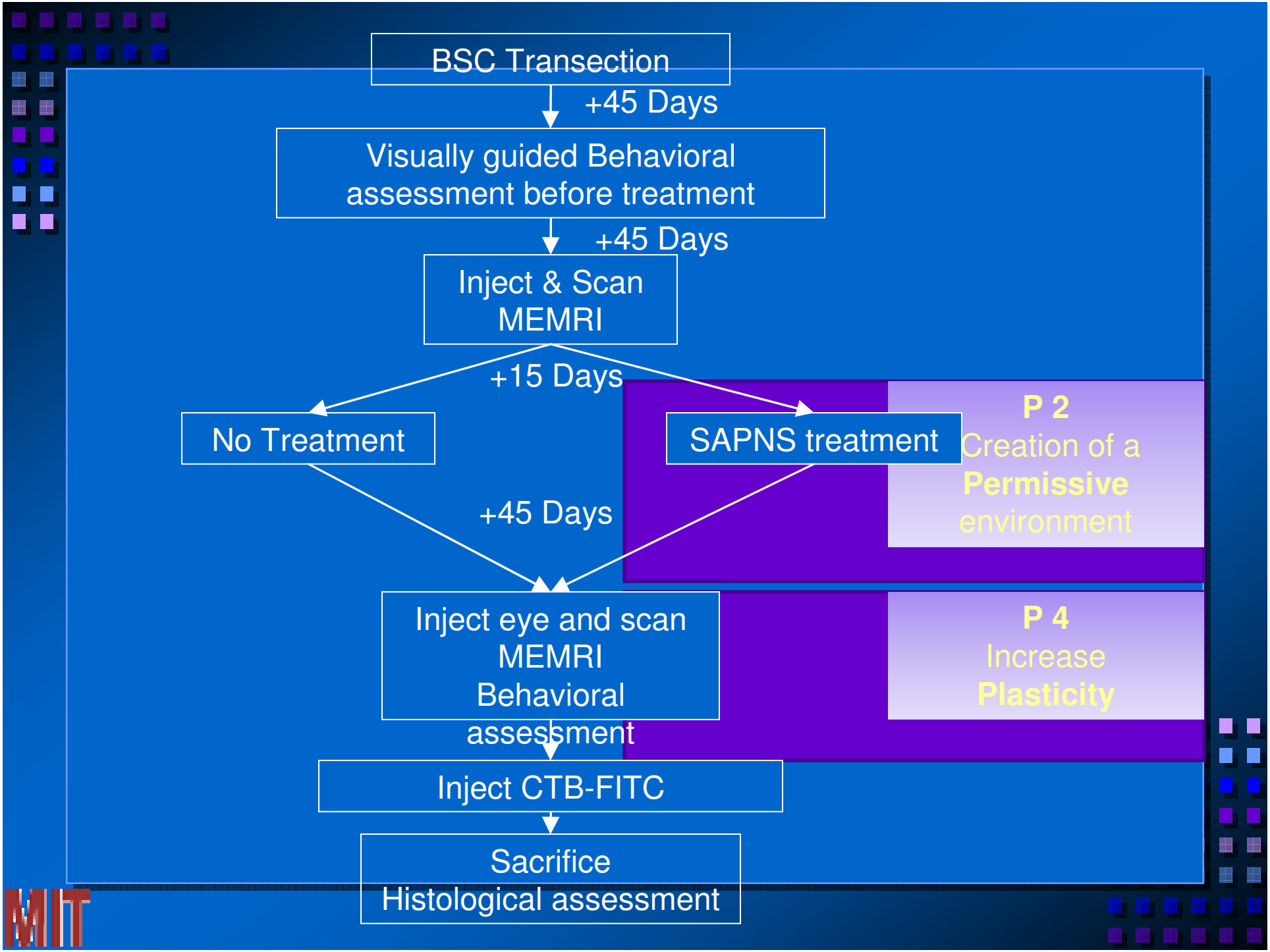


MRI and HRP







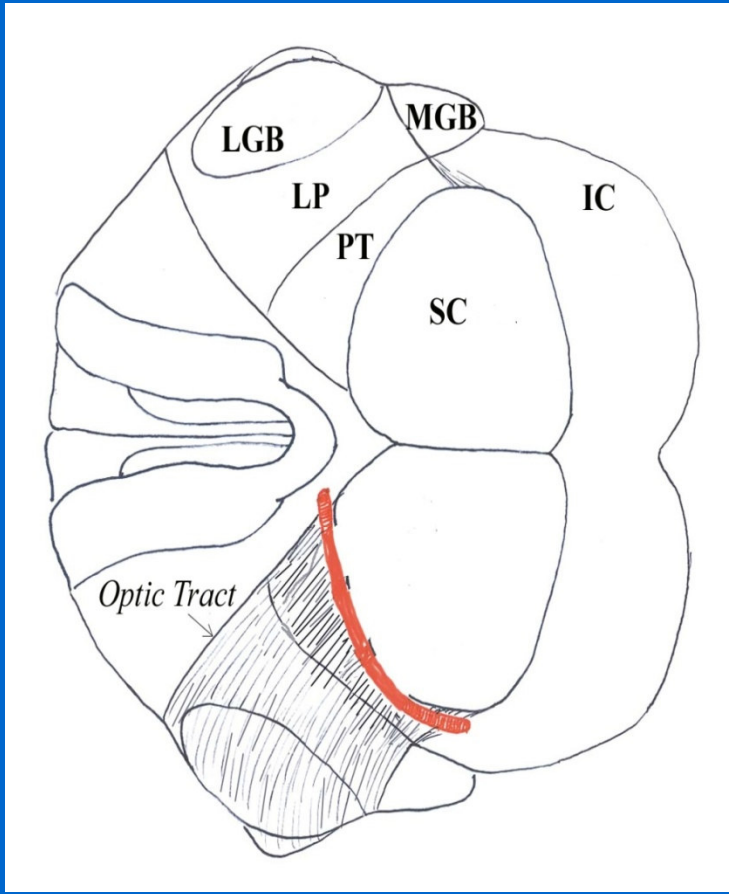

BSC Transection
+45 Days
Visually guided Behavioral assessment before treatment
+45 Days
Inject & Scan MEMRI
+15 Days
No Treatment
SAPNS treatment
P 2
Creation of a Permissive environment
+45 Days
Inject eye and scan MEMRI Behavioral assessment
P 4
Increase Plasticity
Inject CTB-FITC
Sacrifice Histological assessment

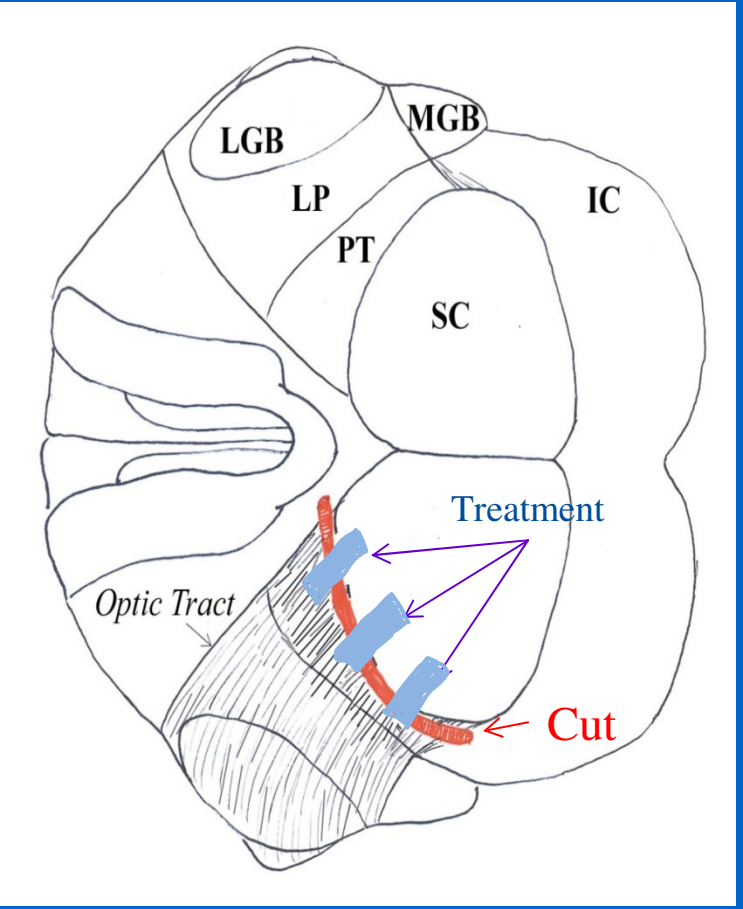
Experimental Timeline Chronic

- Day 1 Inject eye and scan
- Day 8 Cut brachium of SC
- Day 97 Inject eye and scan
- Day 105 Re-operate and treat with SAPNS
- Day 170 Inject eye and scan

Using a 7 Tesla fMRI and nano contrast agent to visualize regeneration of axons in vivo after chronic injury in the hamster optic tract (2007) *Abstracts, SFN*

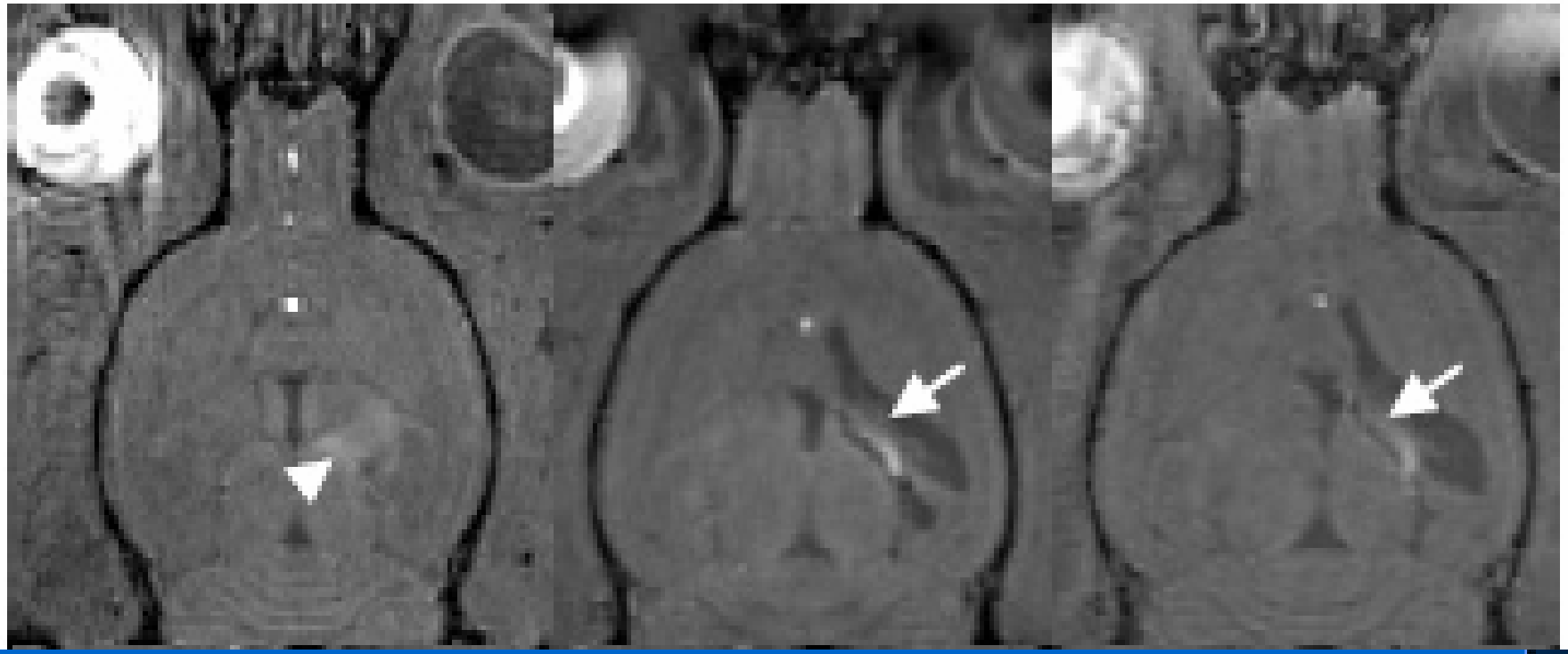
Cut and treated



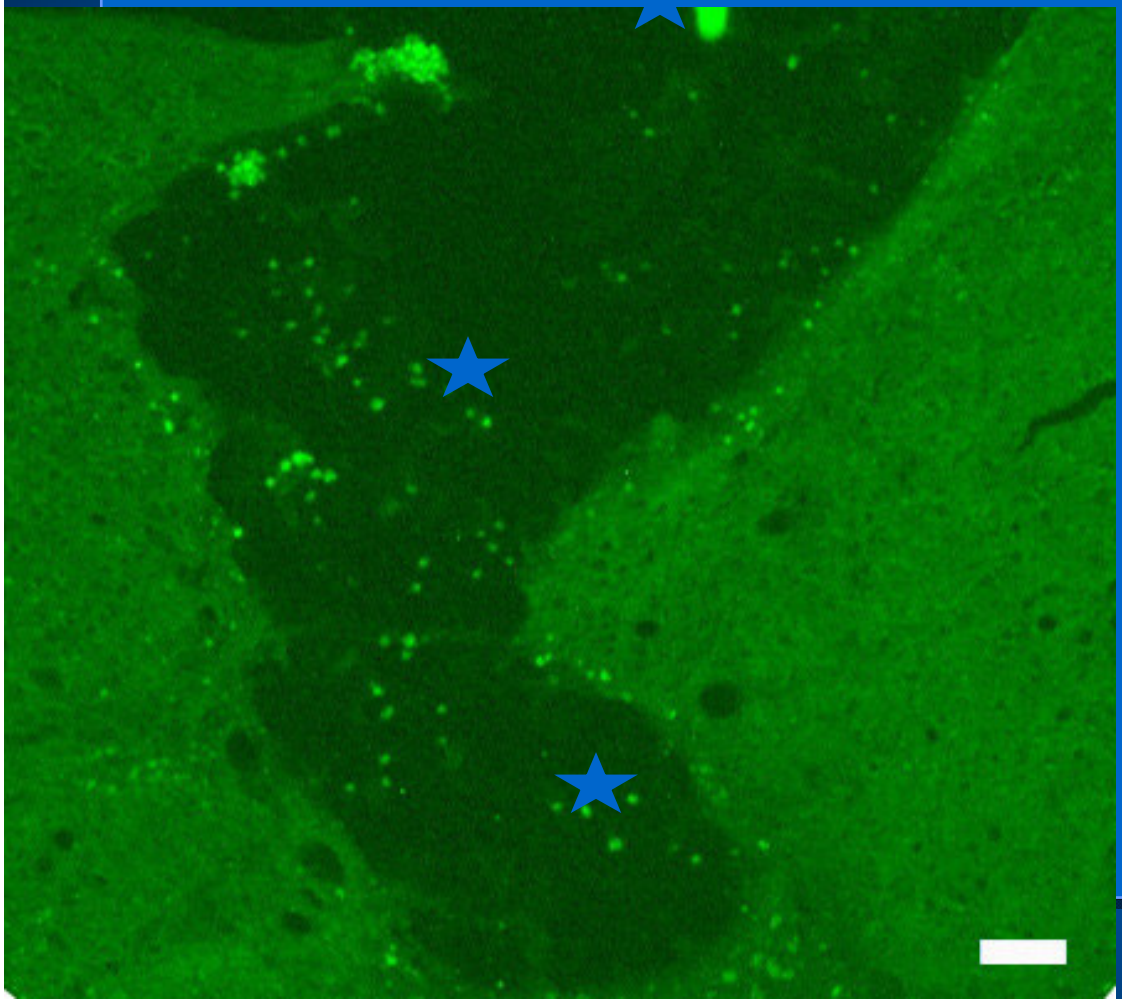


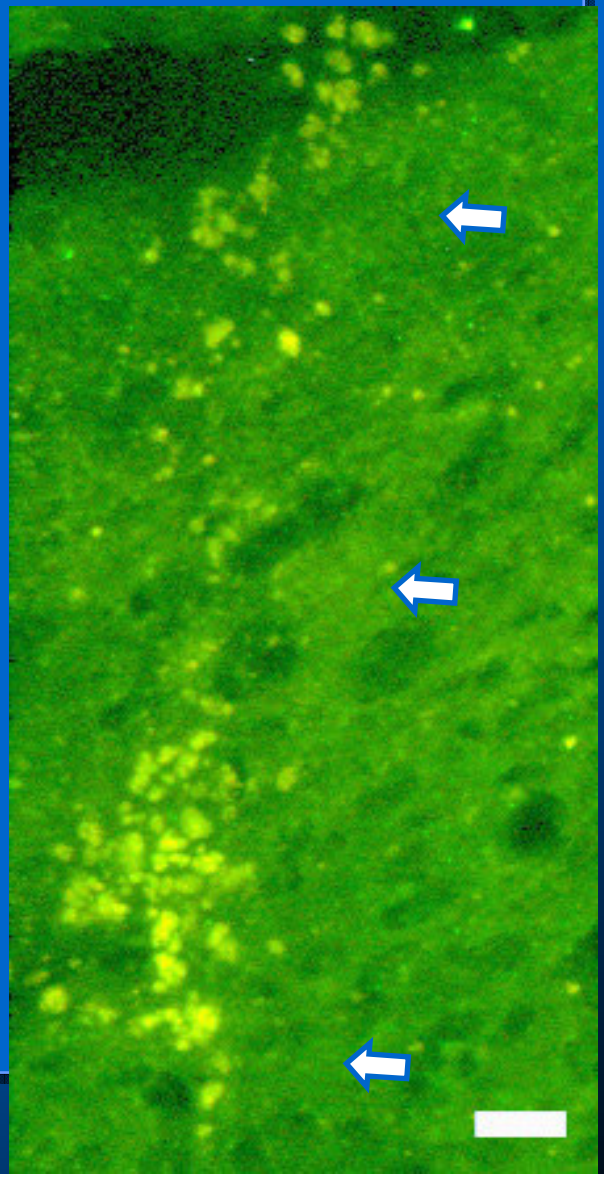
Optic tract tracing and regeneration *in vivo*

(i)

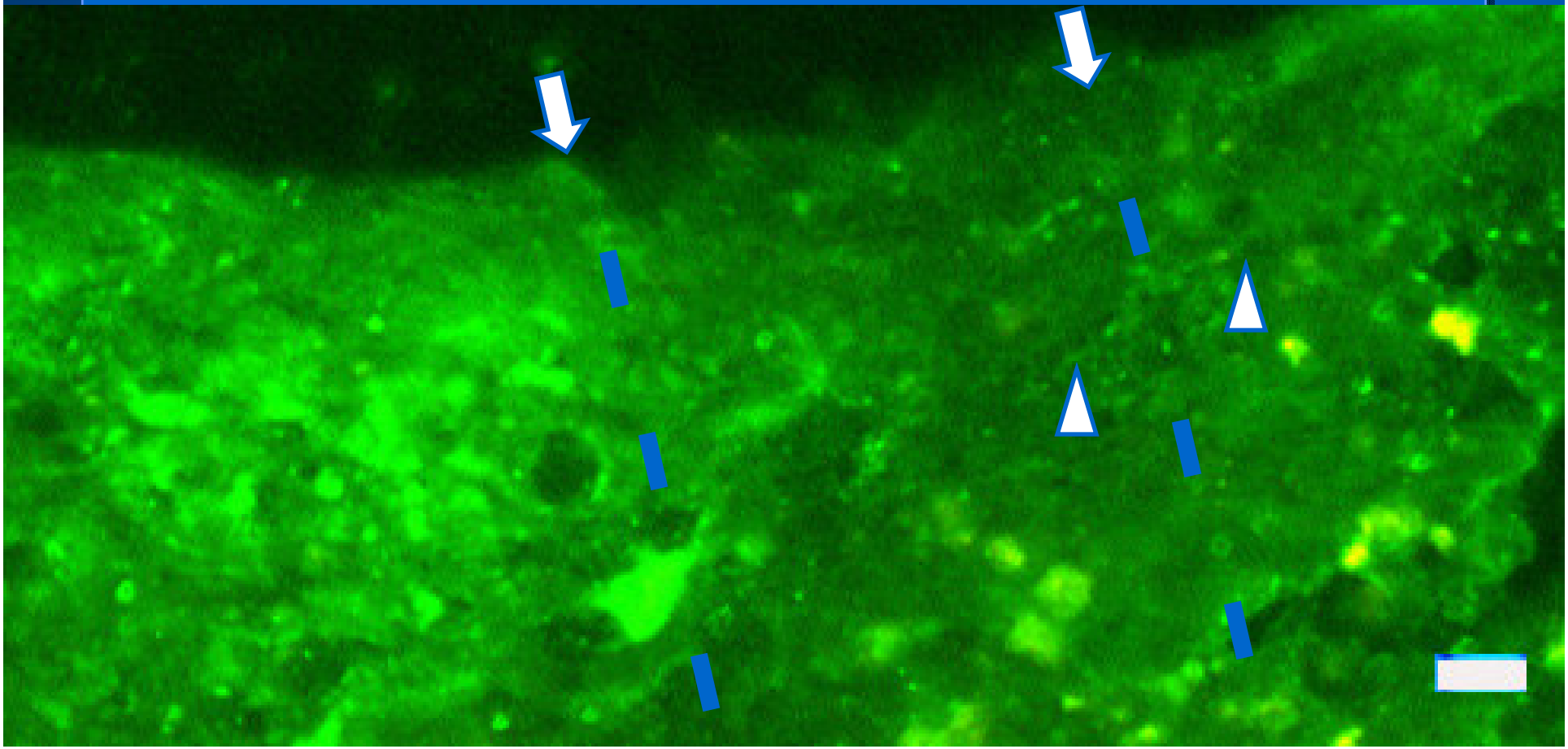


Cut and treated

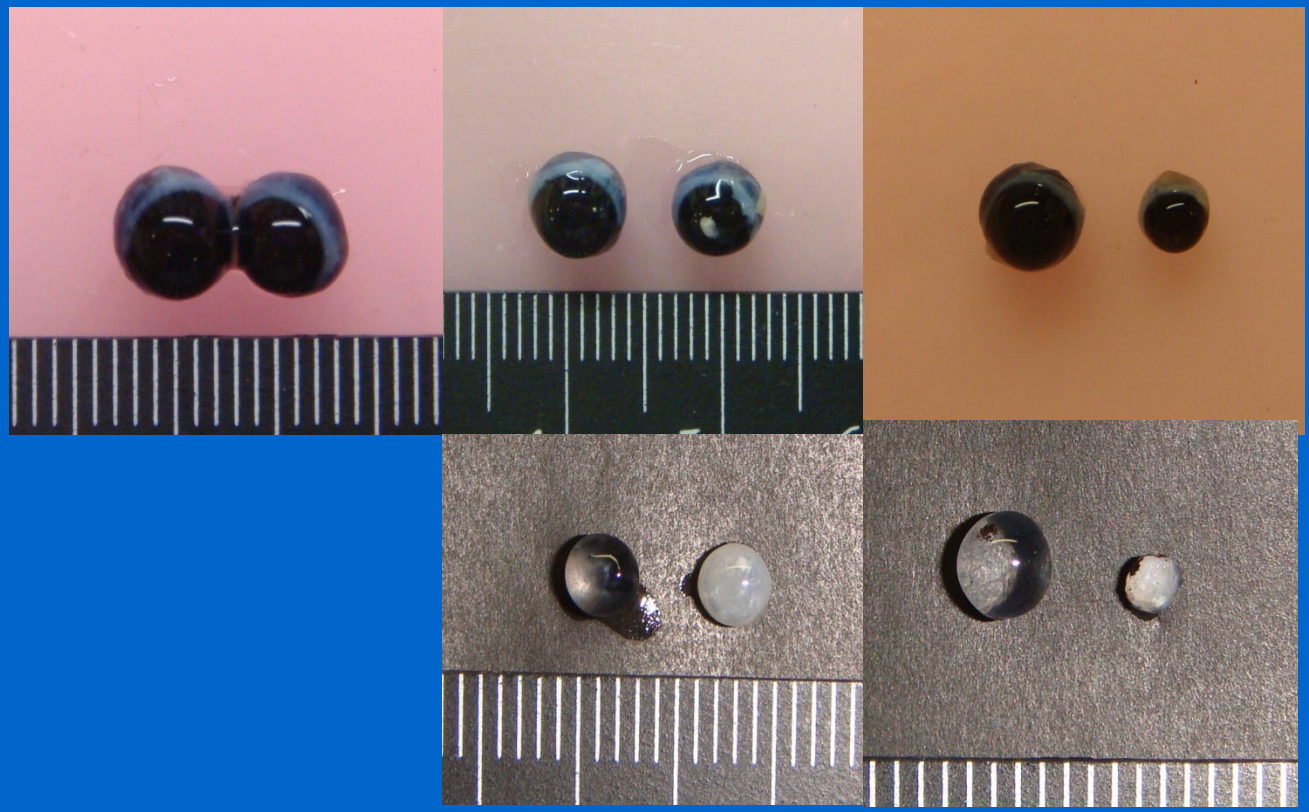




Complete healing of the tissue and axons growing through the repaired site



Not all contrast agents are good

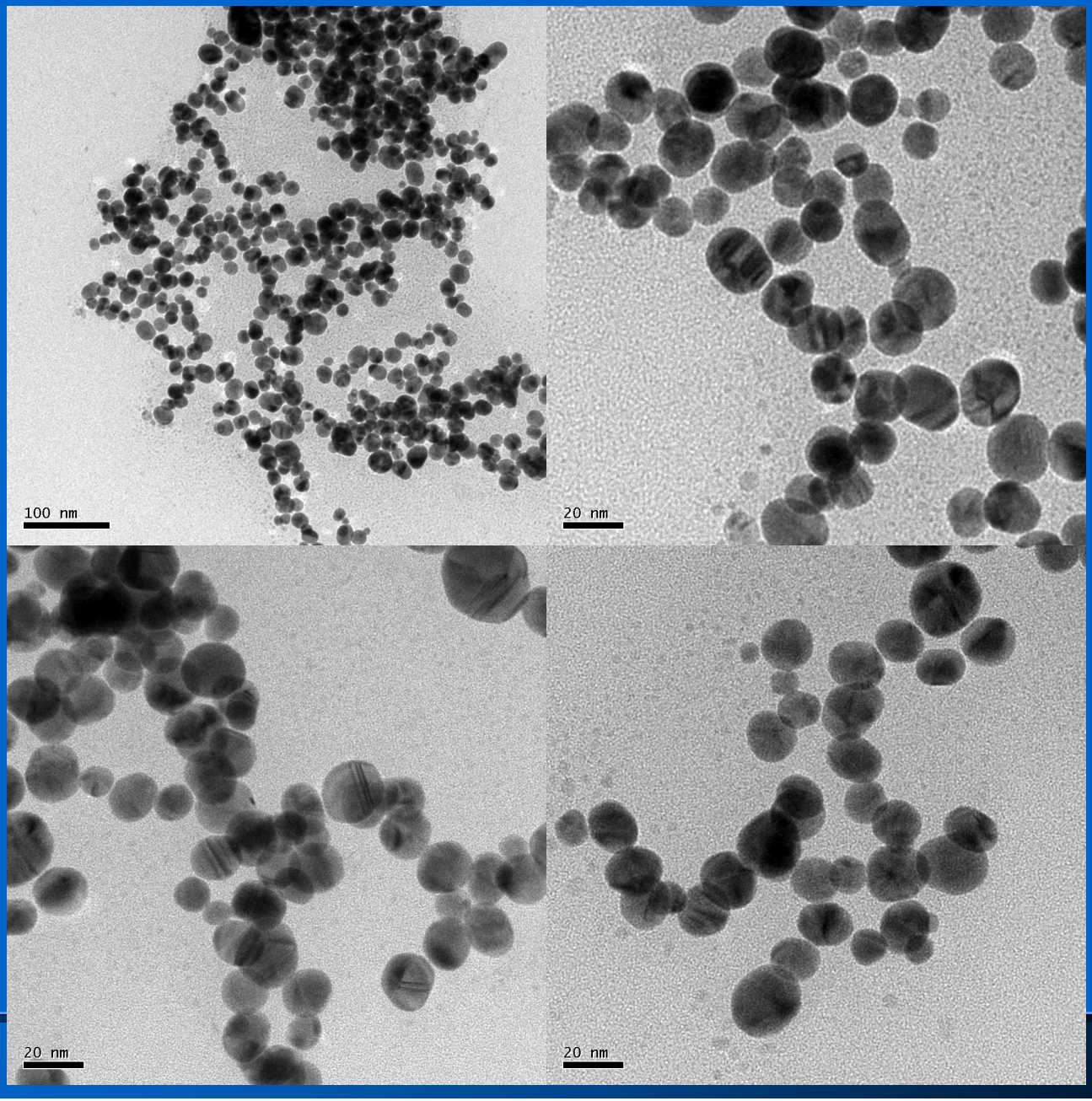


80% of RGCs died due to contrast agent and trauma to optic tract

- 20% survived
- 15% regenerated

New Agents to deal with the toxicity of current contrast agents

Contrast and Transport Particle (CTP9)



Nano
contrast enhancement agents

- *In vivo* imaging
- To follow regeneration as it happens
- It allows for the testing of circuits in the brain
- Endpoint measures
  - Therapeutic relevance

Prescription of Rehabilitation

- Goal
  - Be able to write a prescription for rehabilitation
  - Today
    - Physical therapy for 6 months reassess
  - Future
    - Deficit indicates that the following rehabilitation is possible at the following times
      - Immediate : exercise muscle to maintain tone
      - 3 weeks left arm will show signs of movement and feeling proceed with training on motor feedback system
      - MRI to check progress of axon regrowth

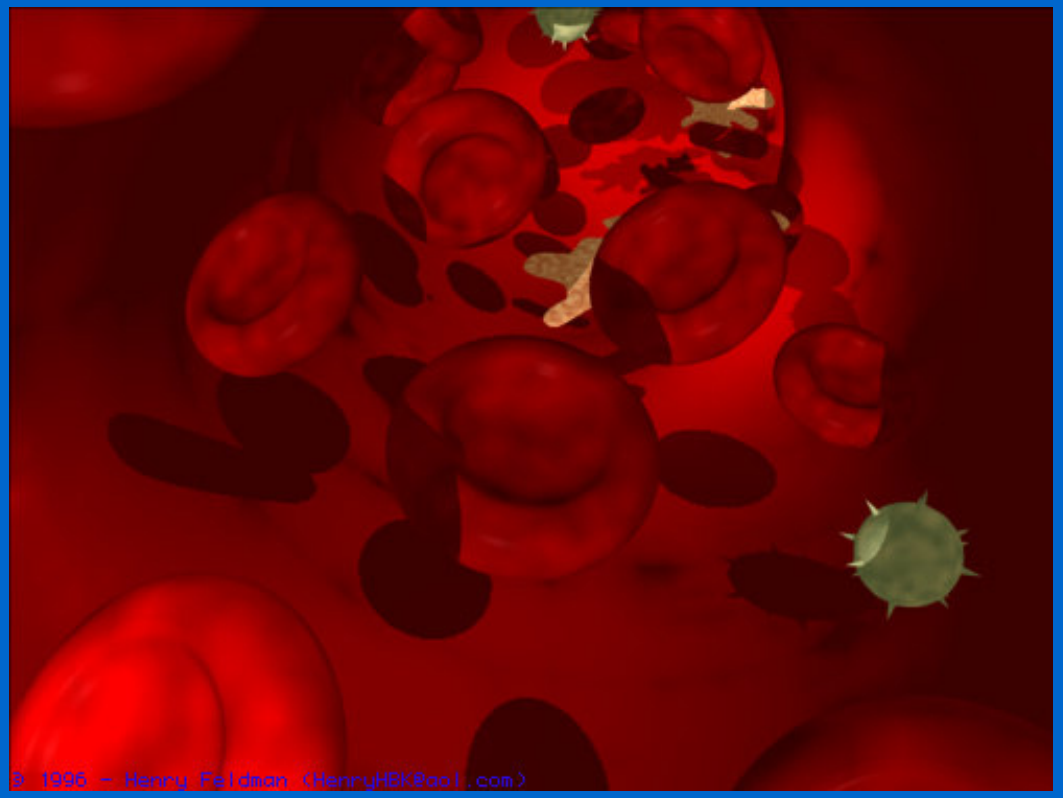
Regeneration
Spinal cord injury / Stroke

- How long should you wait before you try additional patients?
  - If the treatment will take 5 years to be effective, however you can show progress with the MRI should you wait for five years on 100 patients before you treat the rest?
  - How about progress in glaucoma with DTI?
    - Alleviating Symptoms
    - What about reduction in the disease rate?

Can we use an MRI for:

- ADME?
- Dose localization?
- Side effect profile?
- What is the limit of the tool?
- Is MRSPECT allowed for diagnosis and treatment planning for Biochemical imbalances? Why not?

Nano hemostat solution (NHS-1): Immediate hemostasis at the nanoscale

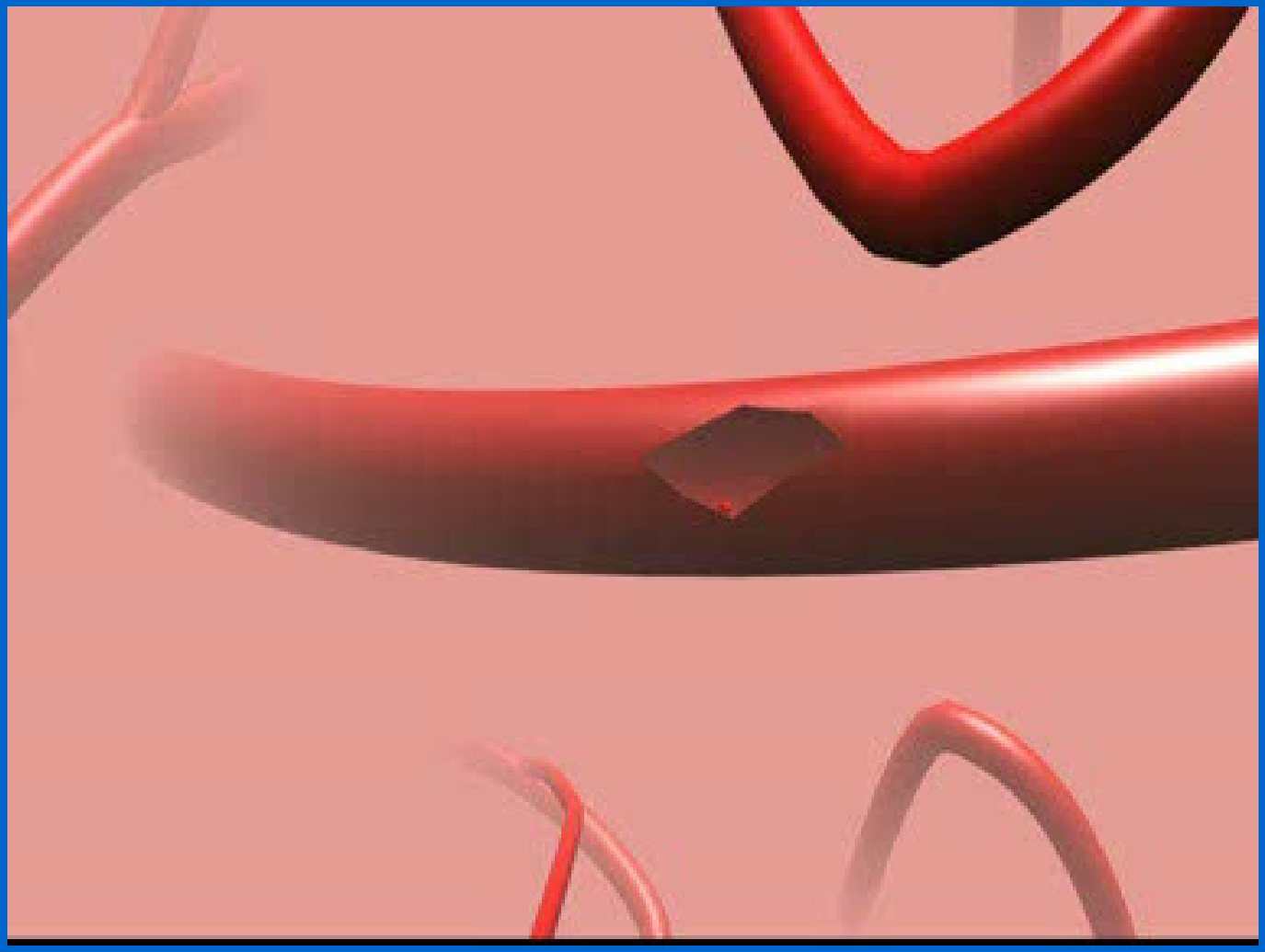


Ellis-Behnke, R. G., Y.-X. Liang, D. K. C. Tay, P. W. F. Kau, G. E. Schneider, S. Zhang, W. Wu and K.-F. So. Nano hemostat solution: immediate hemostasis at the nanoscale. *Nanomedicine: Nanotechnology, Biology, and Medicine*. 2: 207-15 (2006)

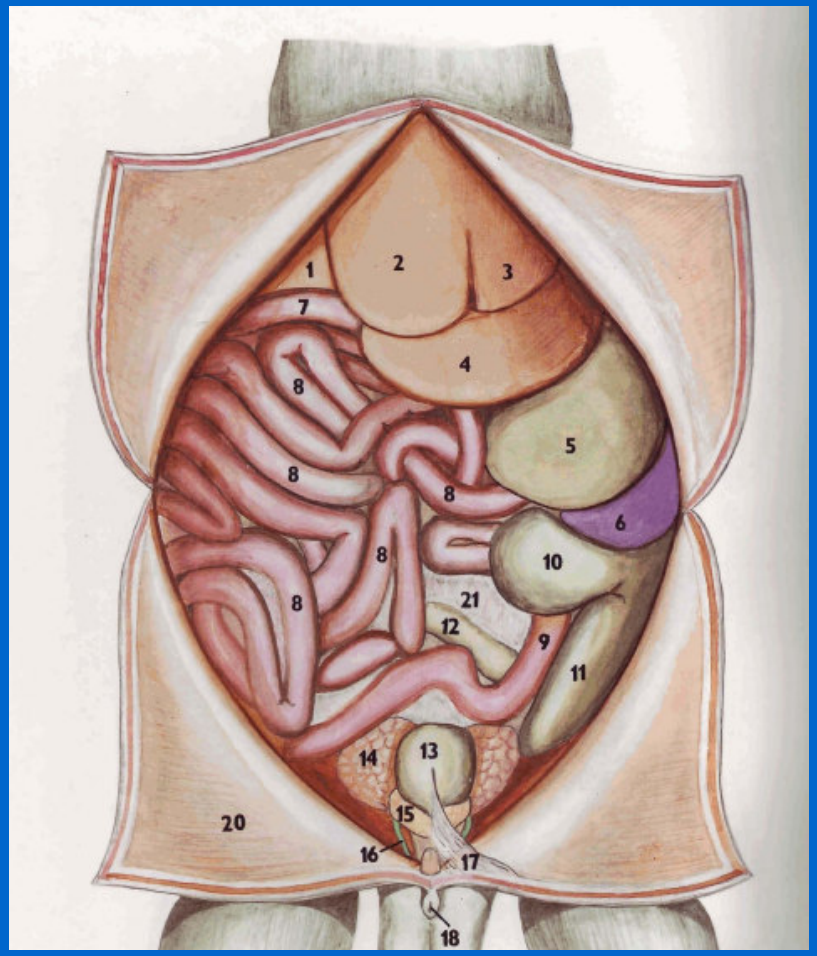
Blood flow

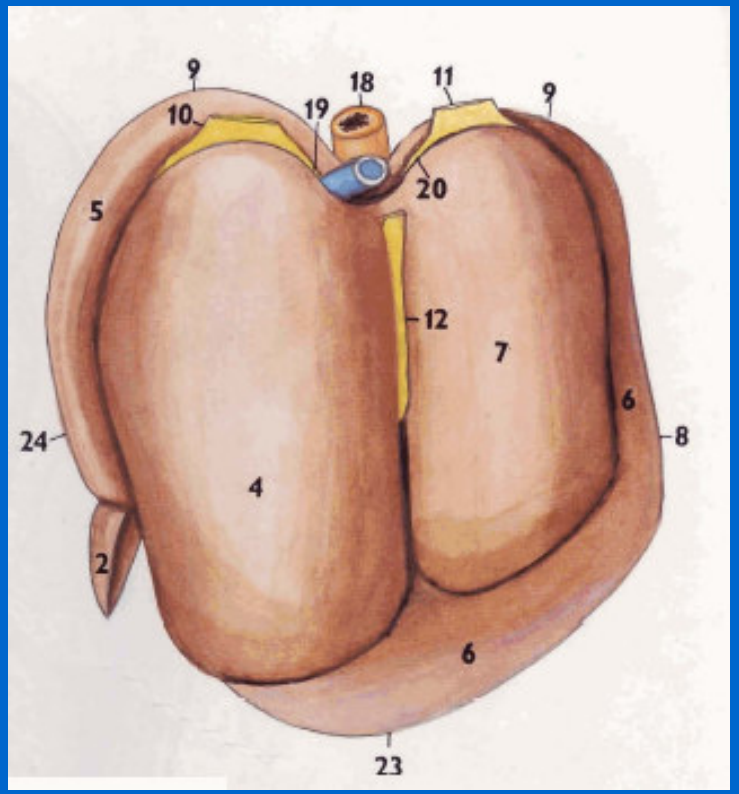
- How do you stop blood flow?
  - Clot
  - Block with Sponges / Bandages
  - Clamp
  - Pressure
  - Cauterize (heat, electric, laser)
  - Vasoconstriction (chemical)

Hemostasis



Rat Liver

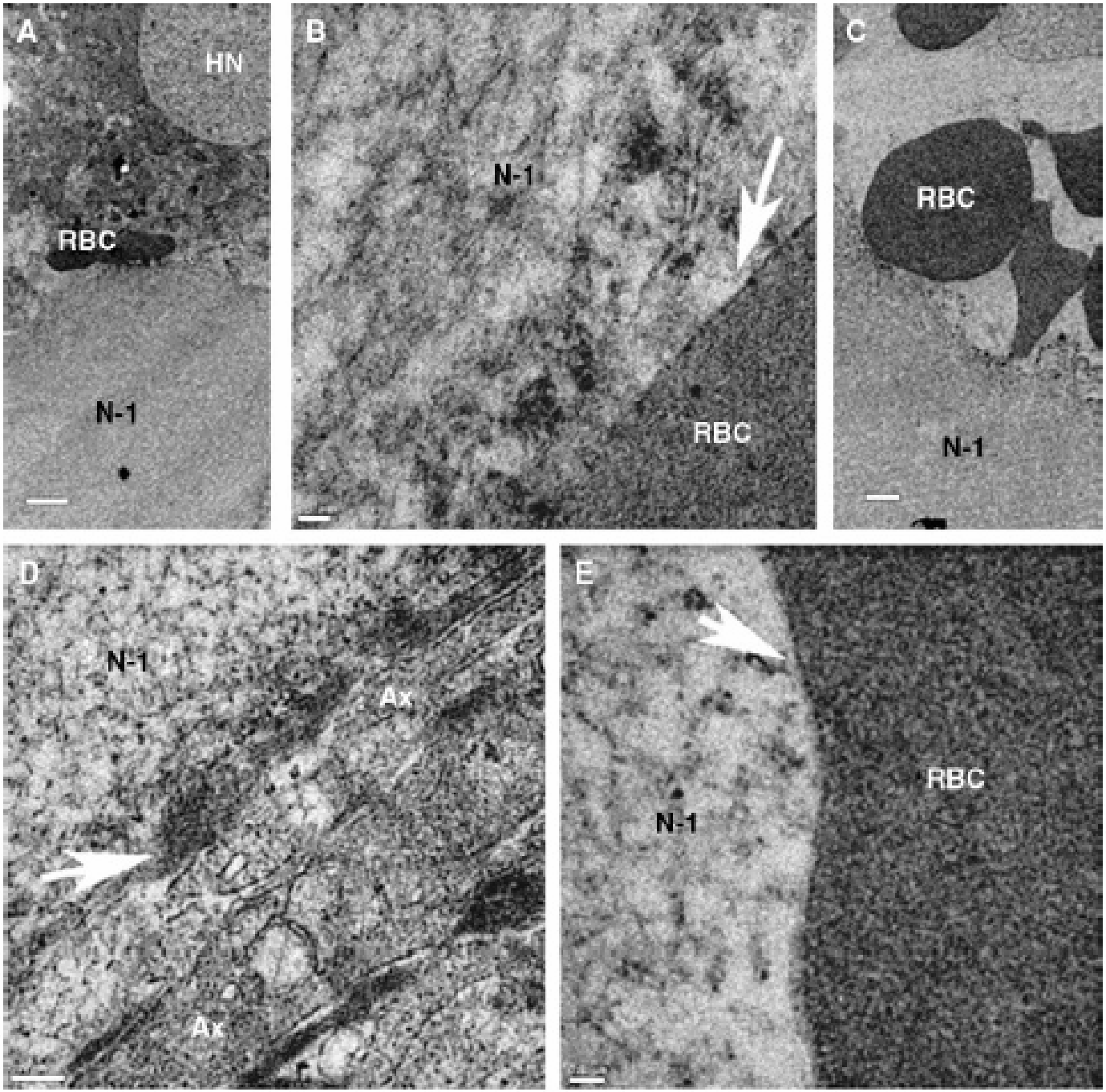




Pictures taken from

A color atlas of Anatomy of small laboratory animals volume 2
Popesko, Rajtova, Horak 2003

1% NHS-1 Liver Rat


A
HN
RBC
N-1
B
N-1
RBC
C
RBC
N-1
D
N-1
Ax
Ax
E
RBC
N-1

Eye

Hemostasis in the eye in less than 15 seconds

Control

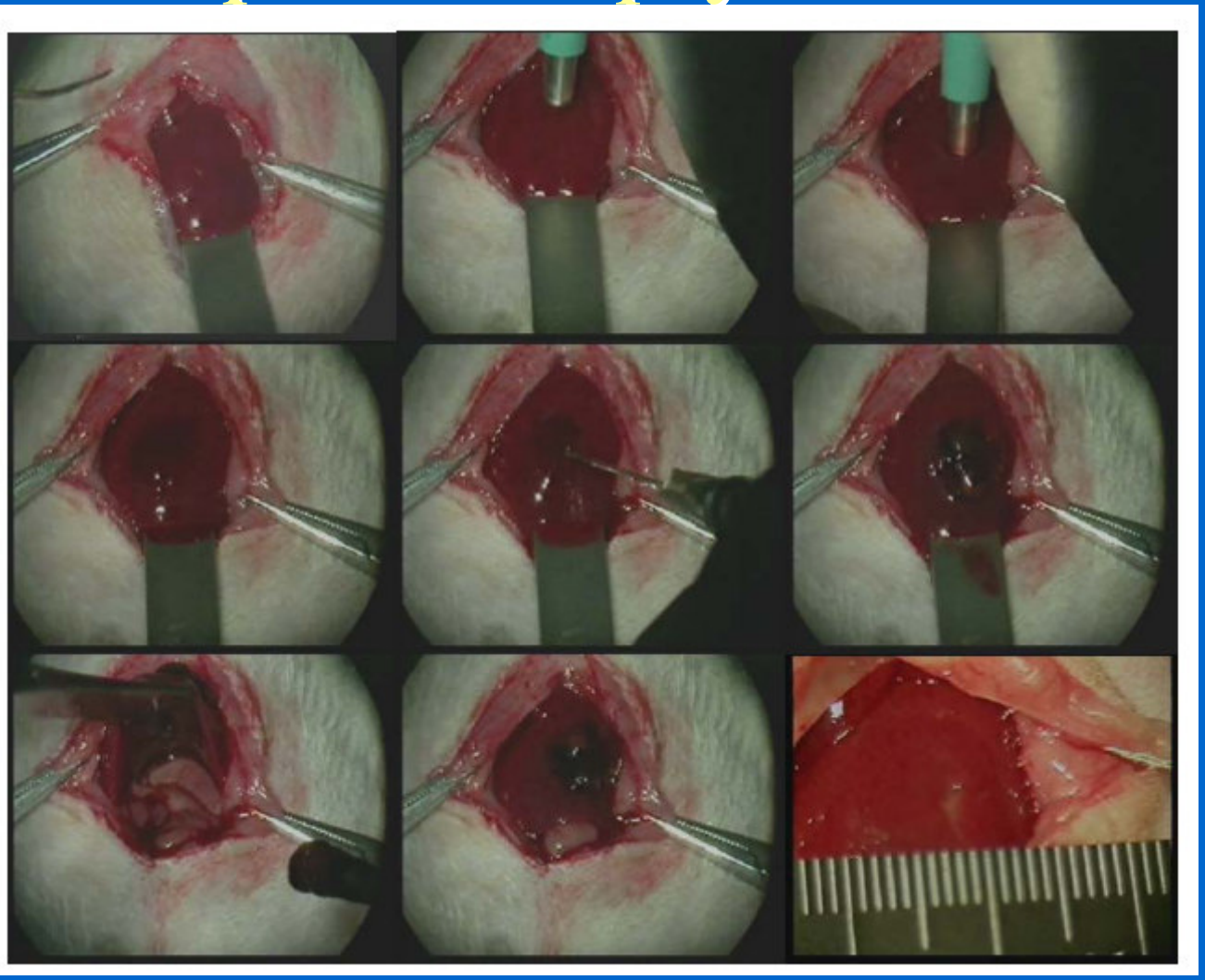
Treated

Hemostasis without clotting

- Who said clotting is requirement for hemostasis?

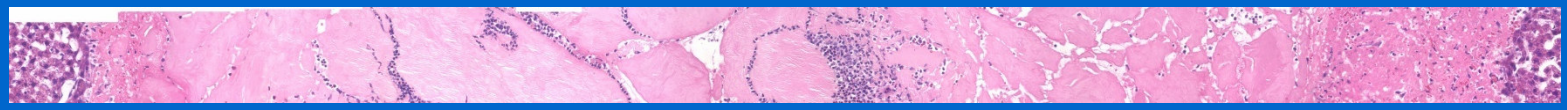
Tissue regeneration in liver

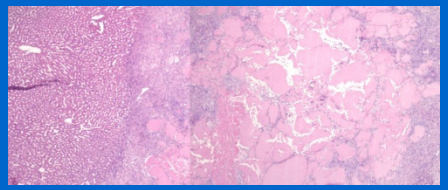
4 mm punch biopsy 6 week survival



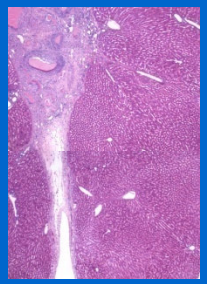
4 mm punch biopsy and Long term liver survival and repair

- 48 hr, 7 day, 6 week



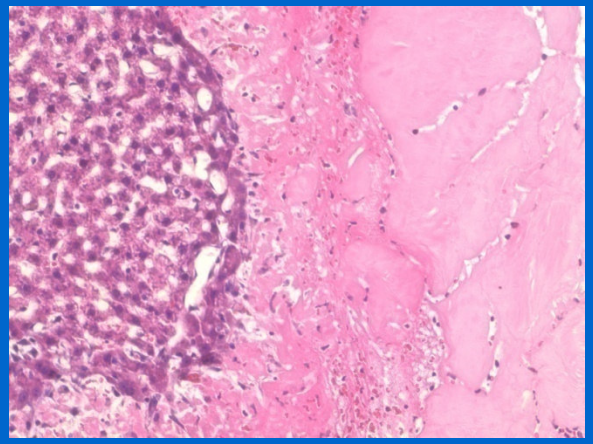


7 day H&E



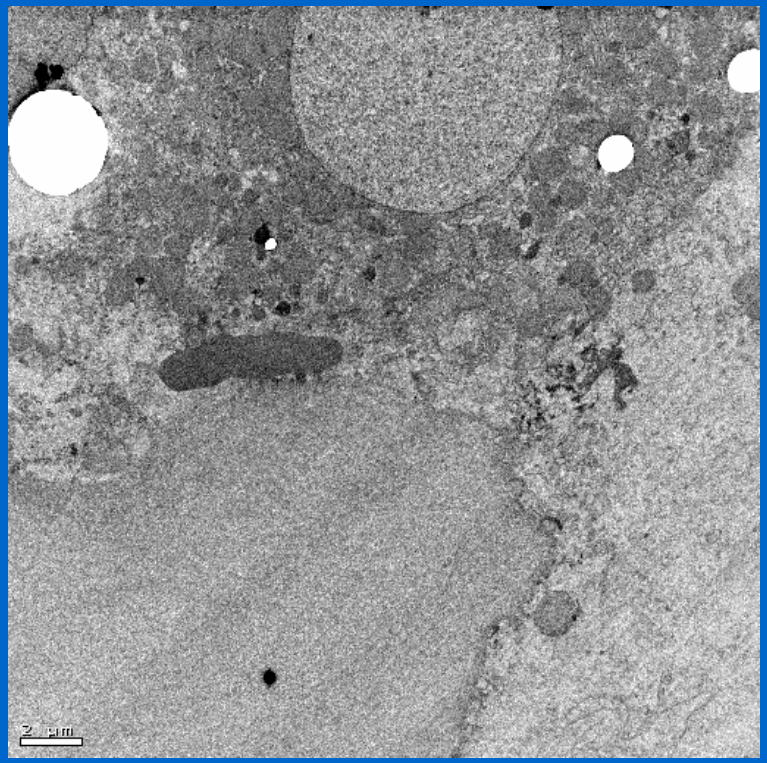
6 week H&E

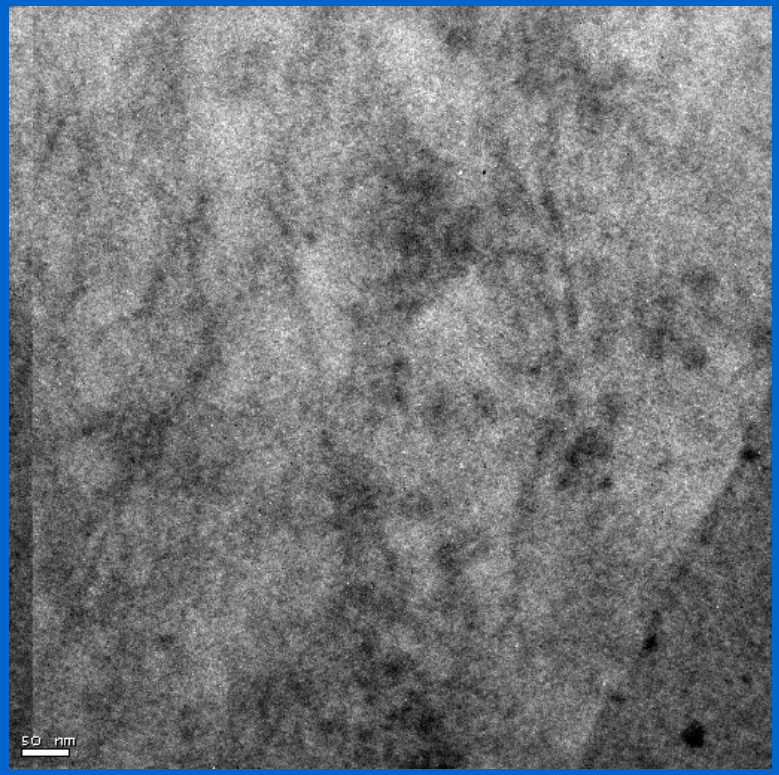
48 hr H&E



Electron microscope (EM) pictures of NHS-1 in liver

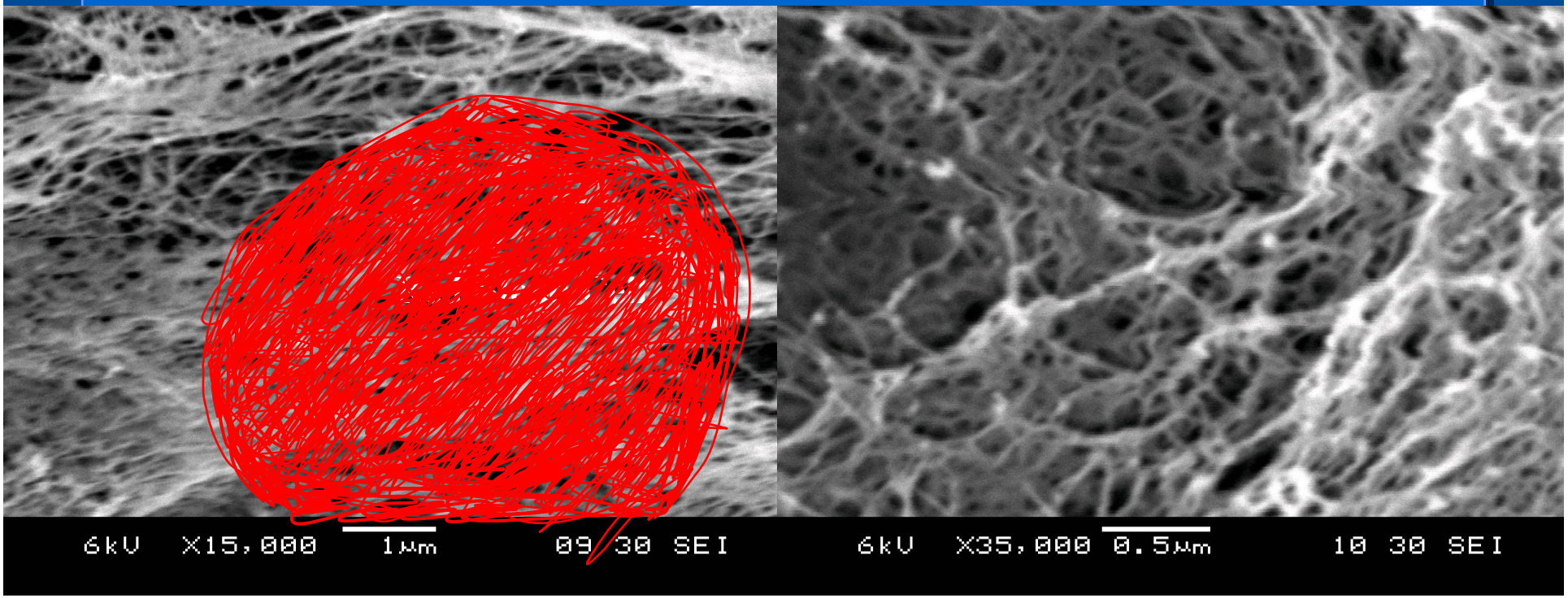
No evidence of platelet aggregation





Self-assembling peptide nanofibers

With red blood cell drawn in



Crystal Clear Surgery

Surgery History

- Brain Surgery (Open air)
- Damage repair (In a shelter)
- Elective surgery
  - Anesthetics
  - Sterile procedures
  - Drapes
  - Tape

Surgery / Anatomy

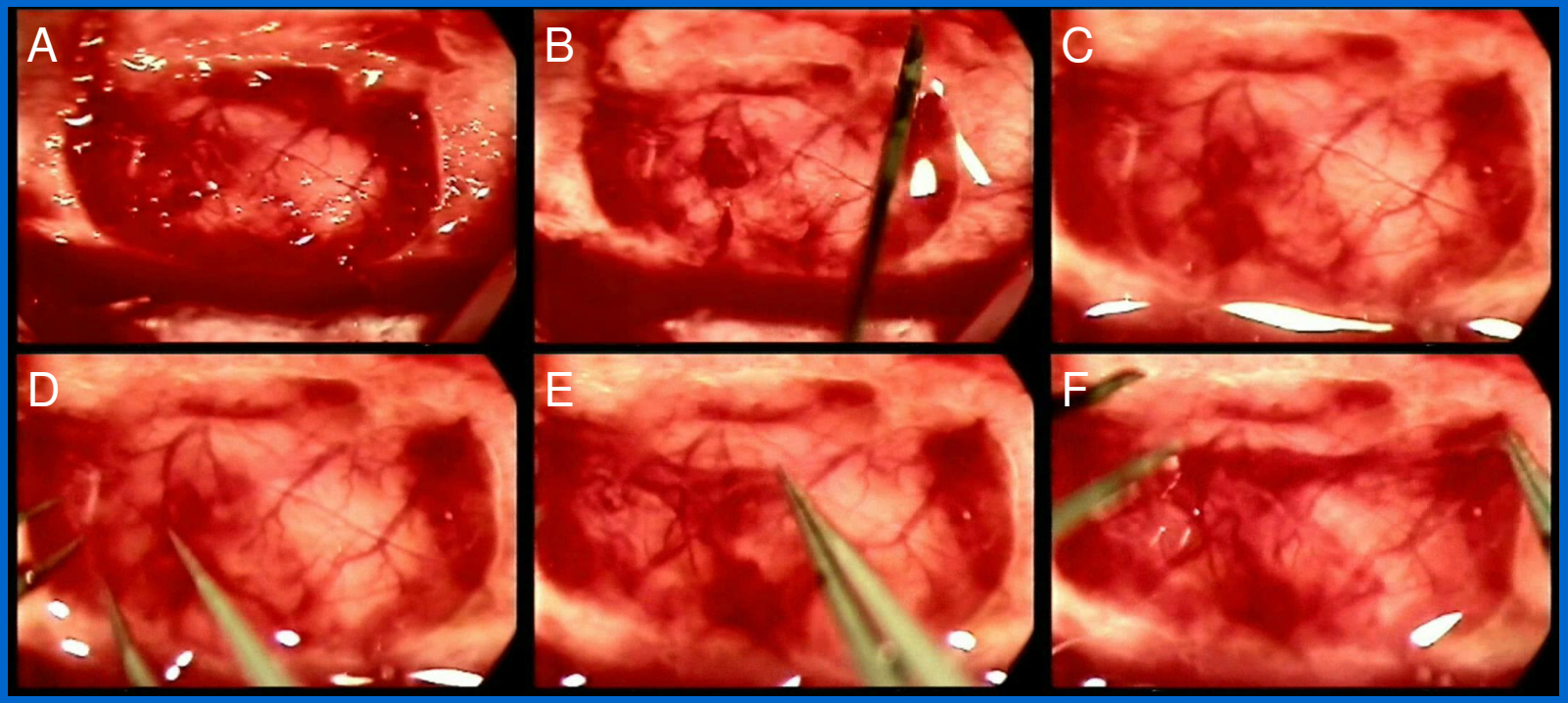
Modern surgery

Crystal Clear Surgery

- Operation through a clear barrier
- New approach to surgery
- 2nd order uses of self assembled nanomaterials
  - Brain (Clear surgery)
  - Limb
  - Tumor resection (Clear surgery)
  - Intraperitoneal cavity (Immobilization of gastrointestinal fluid)
    - Intestine
    - Liver

Ellis-Behnke, *et al* .Abs from 1st Meeting of Amer Acad Nanomedicine, *Crystal Clear Surgery,* Nanomedicine ,Sept 2005

Crystal Clear Surgery in brain removal of dura through 2 cm of SAP liquid on surgical site



Removal of dura under NHS

Clear Brain Surgery

Safety of nanomedicines

- Lack of a way to measure amount and duration of drug delivery release
  - Signaling molecules as response indicators
  - Example: whole animal ADME

Excretion vs Breakdown

- Excretion of an intact material
  - What will it do to the environment?
  - Is it already in the environment?
- Breakdown and then excretion
  - What are the routes
    - Kidney, Liver, Breath
- Distinction needs to be made between intact versus component

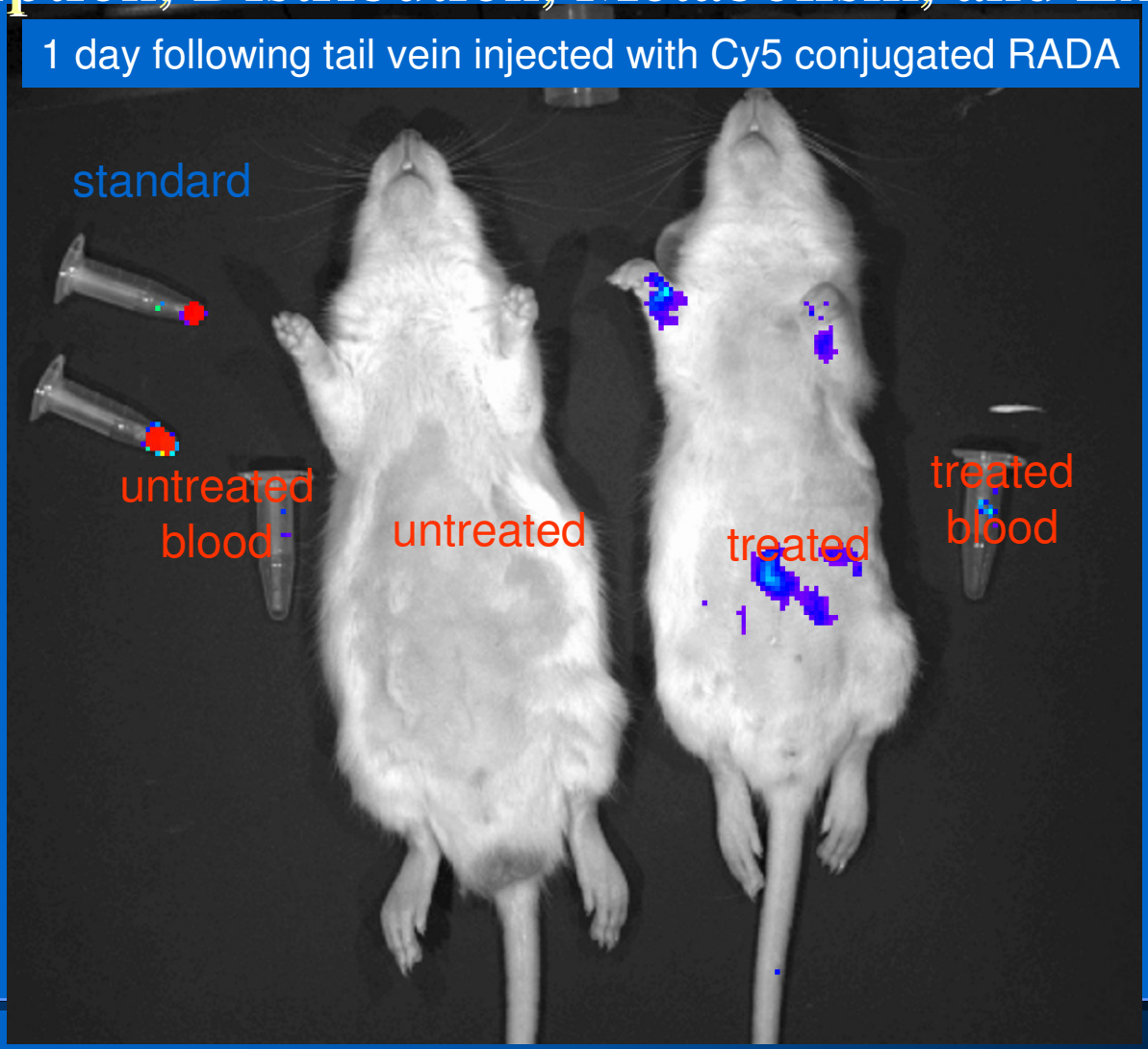
Safety of nanomedicines

- Whole animal ADME example

IR images of internal organs

Whole animal ADME

Absorption, Distribution, Metabolism, and Excretion

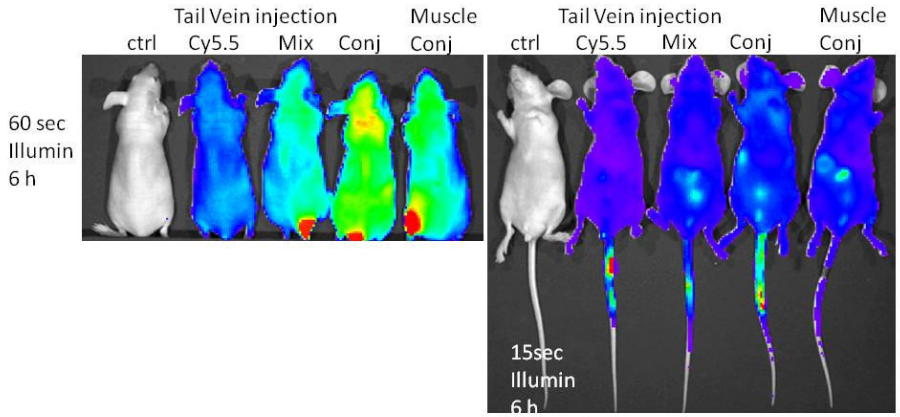


Whole animal ADME

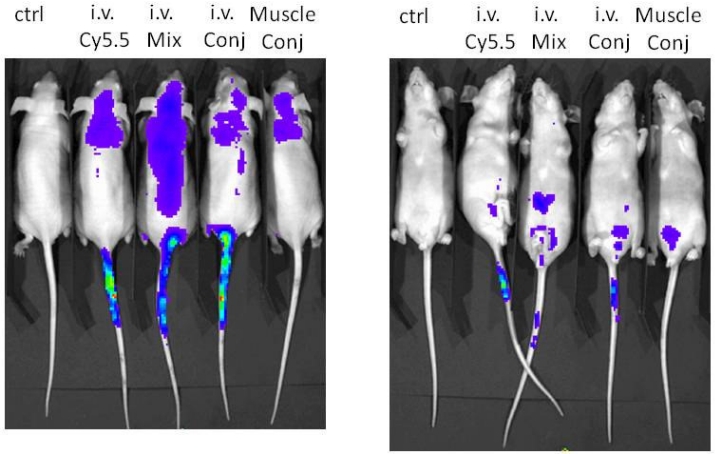
Absorption, Distribution, Metabolism, and Excretion

Time to clearance

11 Aug Injected 6 hour

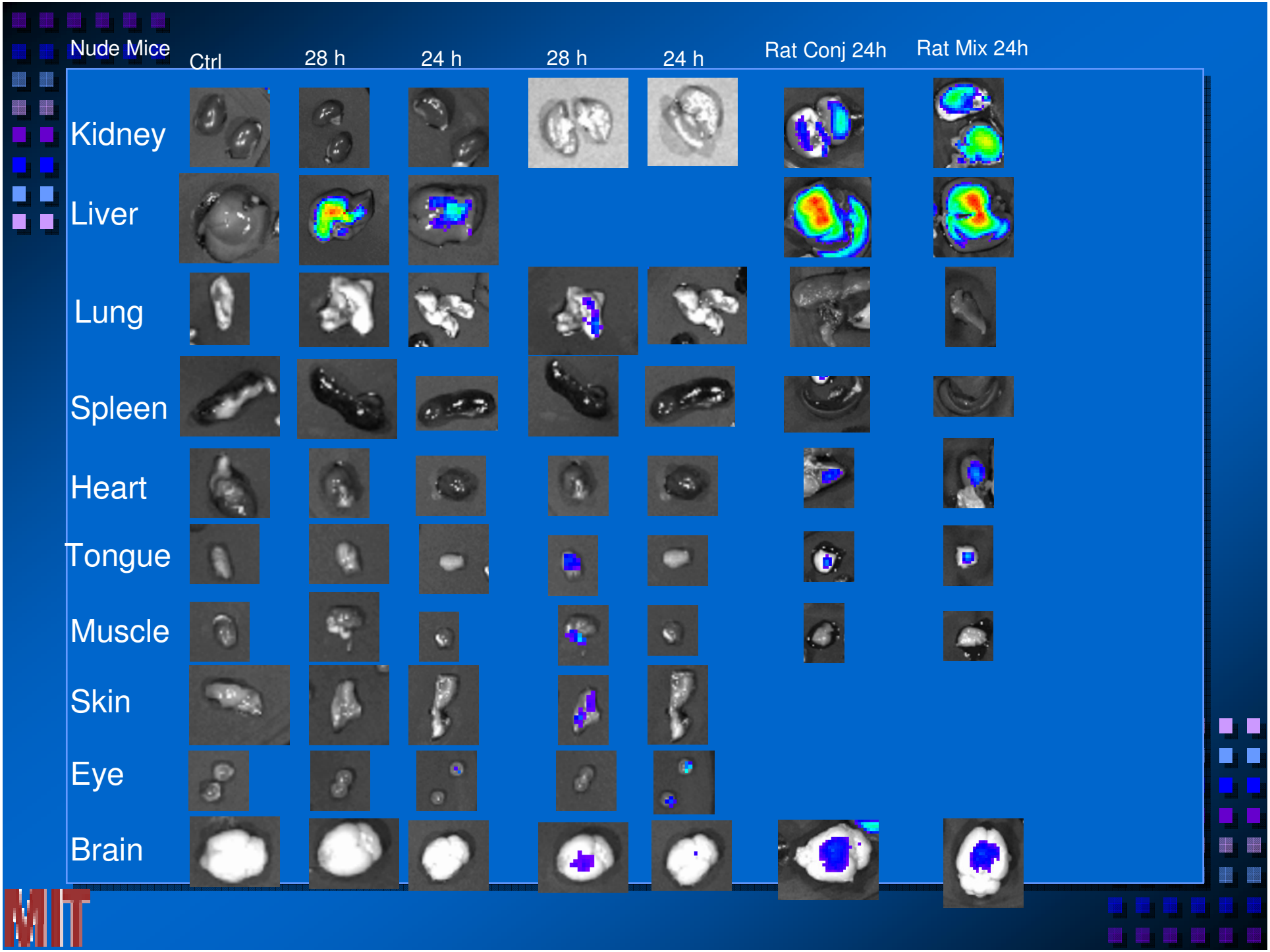


Day 15

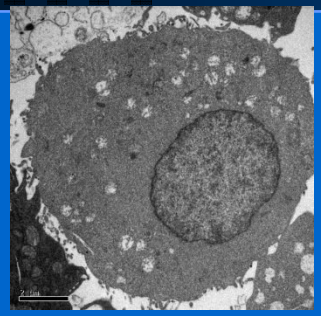


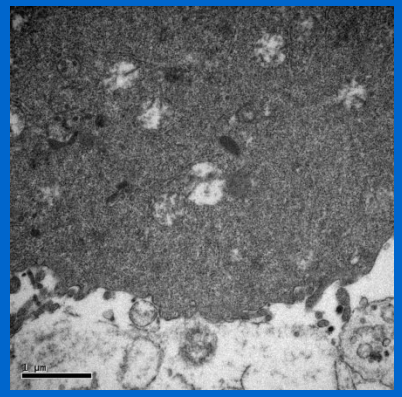
Safety of nanomedicines

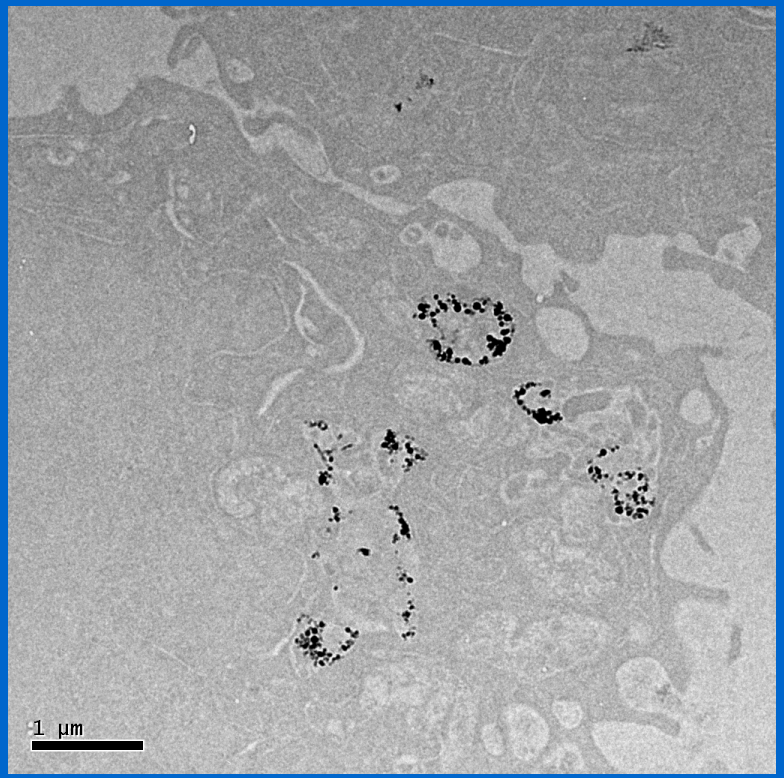
- Invisibility of Blood Brain Barrier to nanotherapeutics
  - Benefit
  - Concern

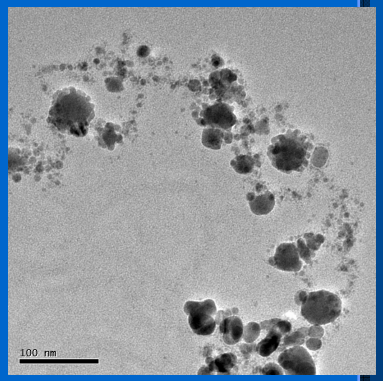

Nude Mice
Ctrl
28 h
24 h
28 h
24 h
Rat Conj 24h
Rat Mix 24h
Kidney
Liver
Lung
Spleen
Heart
Tongue
Muscle
Skin
Eye
Brain

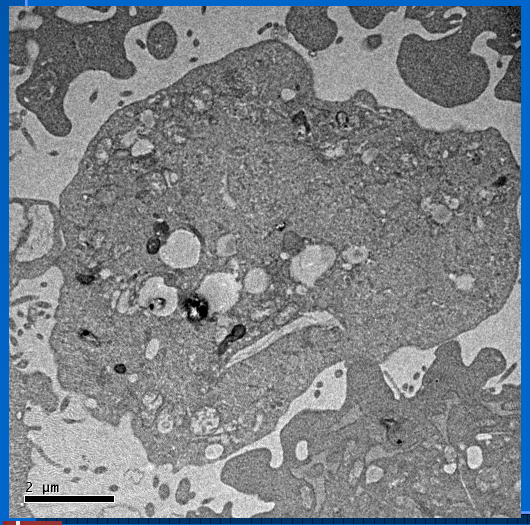
Sub-cellular ADME TEM











Safety of nanomedicines

- Impacts
  - Patients
  - Pharmaceutical industry
  - Manufacturers

Challenges in translational development

- Reversing blindness
- Repairing the brain and spinal cord
- Stopping bleeding in less than 10 seconds
- Controlling the differentiation and maturation of implanted cells
- Preventing human prostate cancer stem cells from metastasizing
- Combination devices for detecting and identifying infectious agents.

Bottlenecks in regulation

- What happens when
  - A device that is for diagnosis will give you information on presence or absence of 100 viruses and identify new strains that have not been seen before?
  - How do you validate a test for a pathogen that has not evolved yet?
  - Do you need to?
- The bar should be lowered to allow for diagnostics.
- With follow-up
- Pandemics don't wait for regulation should technology?

FDA Authorizes TessArae's RM-Flu Chip for Emergency H1N1 Testing

Approval of a test device that will tell you something that is unknown to date.

www.genomeweb.com

TessArae®

TessArray® RPM-Flu 3.1 Testing for Respiratory Pathogens

- Turnkey solution from collection of original specimen to results
- 938,032 array probes interrogate 117,254 basepairs of pathogen gene sequences
- Simultaneous sequence detection and identification of multiple pathogens in single test
- Robust detection and identification of known and previously unknown variant strains (mutations)
- Sensitivity and specificity exceeding gold standard microbial cultures and molecular assay by RT-PCR

Influenza A HA1
Influenza A HA
Influenza A HA
Influenza A HA
Influenza A HA
Influenza A HA
Influenza A HA
Influenza A HA
Influenza A HA9
Influenza A HA10
Influenza A HA11
Influenza A HA12
Influenza A HA13
Influenza A HA14
Influenza A HA15
Influenza A HA16

Influenza A NA1
Influenza A NA2
Influenza A NA3
Influenza A NA4
Influenza A NA5
Influenza A NA6
Influenza A NA7
Influenza A NA8
Influenza A NA9
Influenza A Mtx
Influenza A NS
Influenza A PB2
Influenza B HA1
Influenza B HA2
Influenza B NA1

Influenza B Mtx

Adenovirus B
Adenovirus C
Adenovirus D
Adenovirus E

Coronavirus (229E)
Coronavirus (OC43)
Coronavirus (NL63)
Coronavirus (SARS Urbani)
Cytomegalovirus (HHV-5)
Enteroviruses:
- Coxsackievirus (5 types)
- Echovirus (8 types)
- Rhinovirus (27 types)

Measles Virus
Metapneumovirus (types A, B)
Parainfluenza 1
Parainfluenza 2
Parainfluenza 3
Parainfluenza 4a
Parainfluenza 4b
RSV A
RSV B
Rubella Virus

Bordatella pertussis
Corynebacterium diphtheriae
Chlamydia psittaci
Chlamydia trachomatis
Chlamydophila pneumoniae
Haemophilus influenzae
Klebsiella pneumoniae
Legionella pneumophila
Moraxella catarrhalis
Mycobacterium kansasii
Mycobacterium tuberculosis
Mycoplasma pneumoniae
Neisseria meningitidis
Pseudomonas aeruginosa
Staphylococcus aureus
Streptococcus agalactiae
Streptococcus pneumoniae
Streptococcus pyogenes

Variola major
Bacillus anthracis
Francisella tularensis
Yersinia pestis

TessArray® RPM assays can be customized for any combination of viruses, bacteria, plasmids, vectors, or recombinants for Identification (Can increase this format by a factor of three)

Technology

- Is this diagnosis or discovery?
- If diagnosis then can't use it! But which country.
- If discovery it is ok?

- Woo PC, Ellis-Behnke RG, et al. Resequencing microarray for detection of human adenoviruses in patients with conjunctivitis. J Clin Virol. 2010 Mar;47(3):282-5.
- Woo PC, Ellis-Behnke RG, et al. Resequencing microarray for detection of human adenoviruses in patients with community-acquired gastroenteritis: a proof-of-concept study. J Med Microbiol. 2010 Jul 29. [Epub ahead of print]

Resequencing microarray for detection of human adenoviruses in patients *with conjunctivitis*

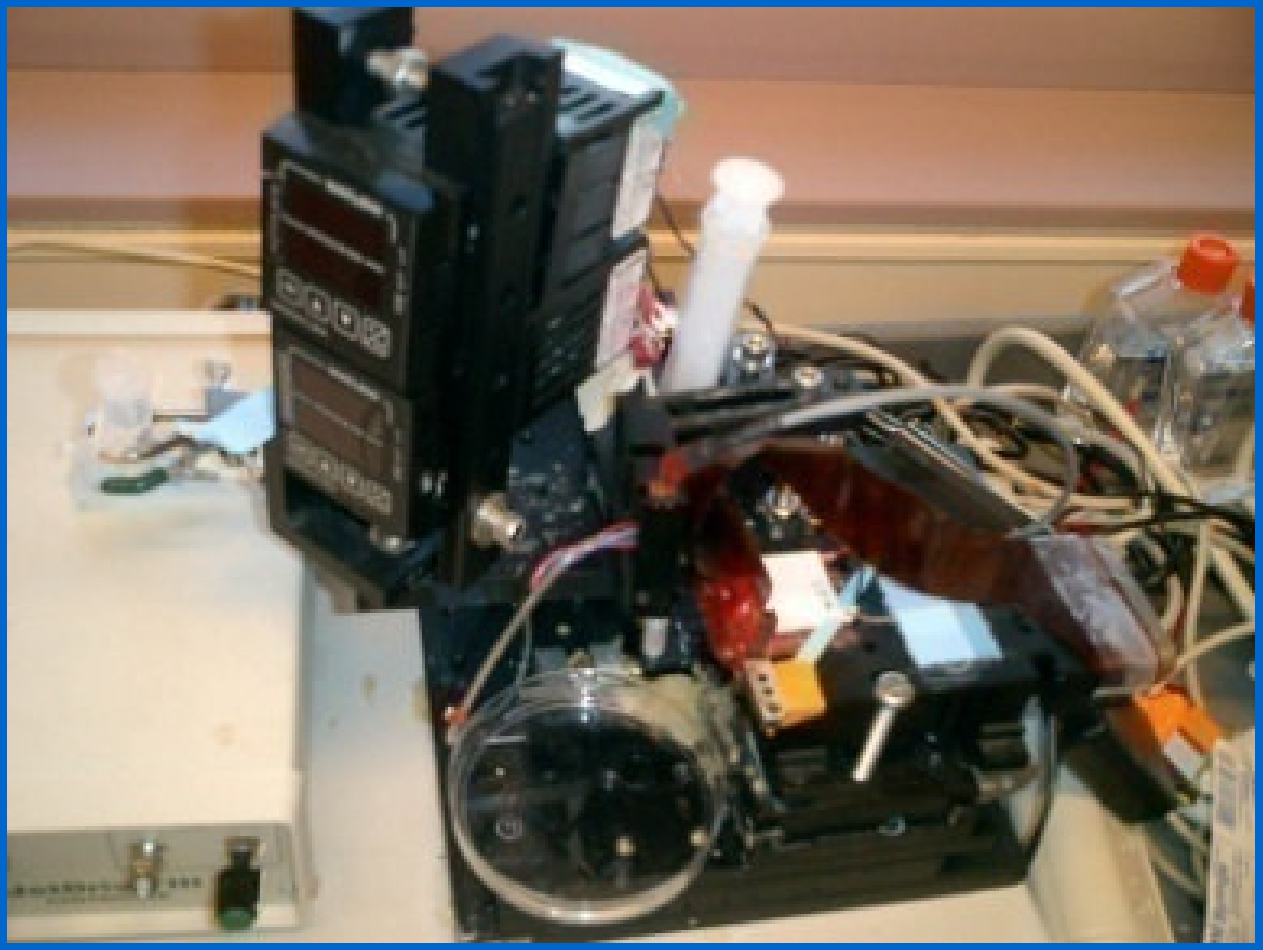
Among 38 patients with conjunctivitis during a 7-month period, bacterial culture was positive in 6 patients *(Haemophilus injluenzae, n = 2; Streptococcus pseudopneumoniae, n = 2; Pseudomonas aeruginosa, n = 1; and Staphylococcus aureus, n = 1).*

For the 32 bacterial culture negative samples, every 4 or 5 samples were pooled and subject to resequencing micro array analysis. Four of these 7 pooled samples were positive for human adenovirus. No other virus or bacterium was detected. PCR and partial sequencing of the hexon genes of human adenovirus on the 38 individual samples showed that 3 and 4 samples contained human adenoviruses species D and B respectively.

- Change the setting to a waiting room full of patients? H1N1
  - Knowing you don't have it is as important as if you do.

Printing gradients

Printer



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OFFENDING COMMAND: ~

STACK:
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