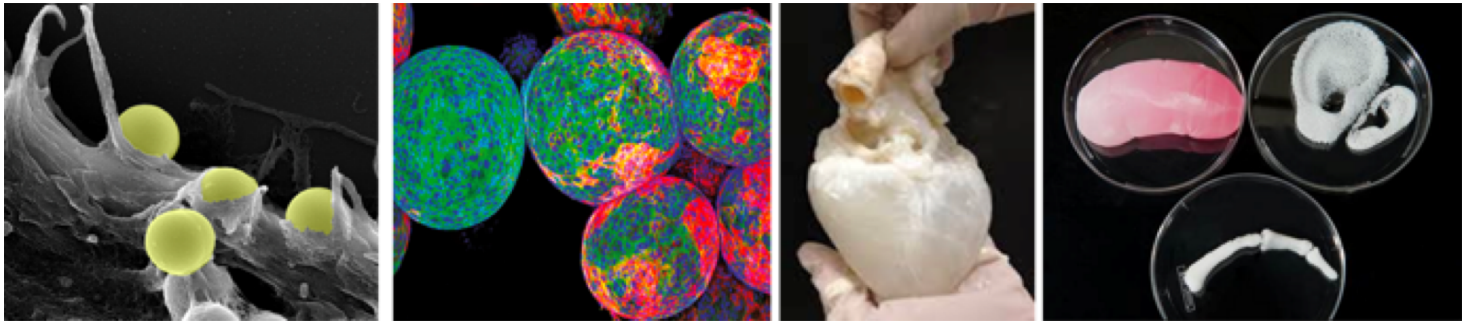
Master Biomedical Science- track Regenerative Medicine



Dr. Elizabeth Rosado Balmayor, *Assistant professor*

Dr. Sabine van Rijt, *Assistant professor*
coordinator MBS1401, specialization coordinator
s.vanrijt@maastrichtuniversity.nl

Outline talk:

What is RM

Track content

Why choose RM

After talk:

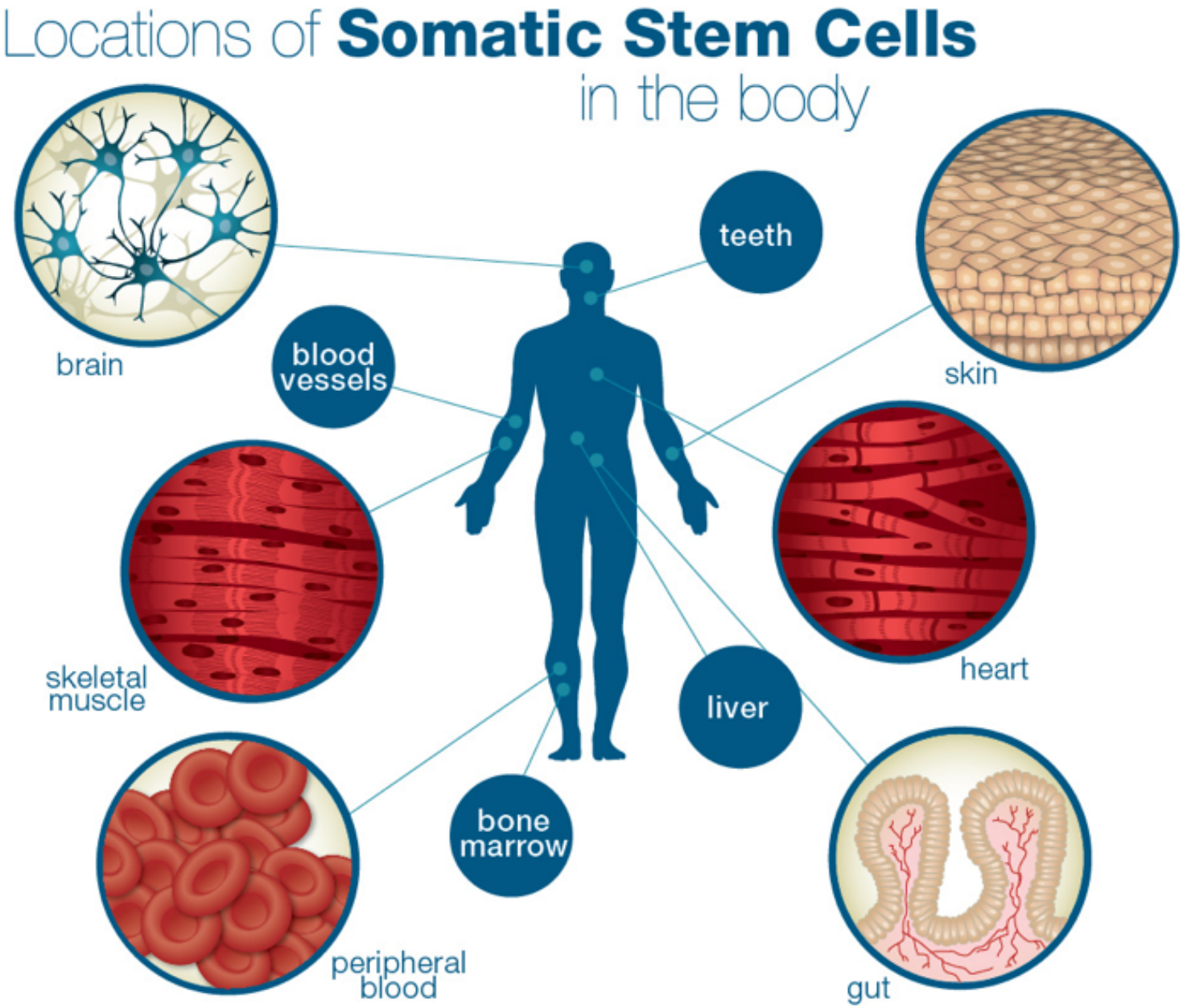
Labtour (please sign up)

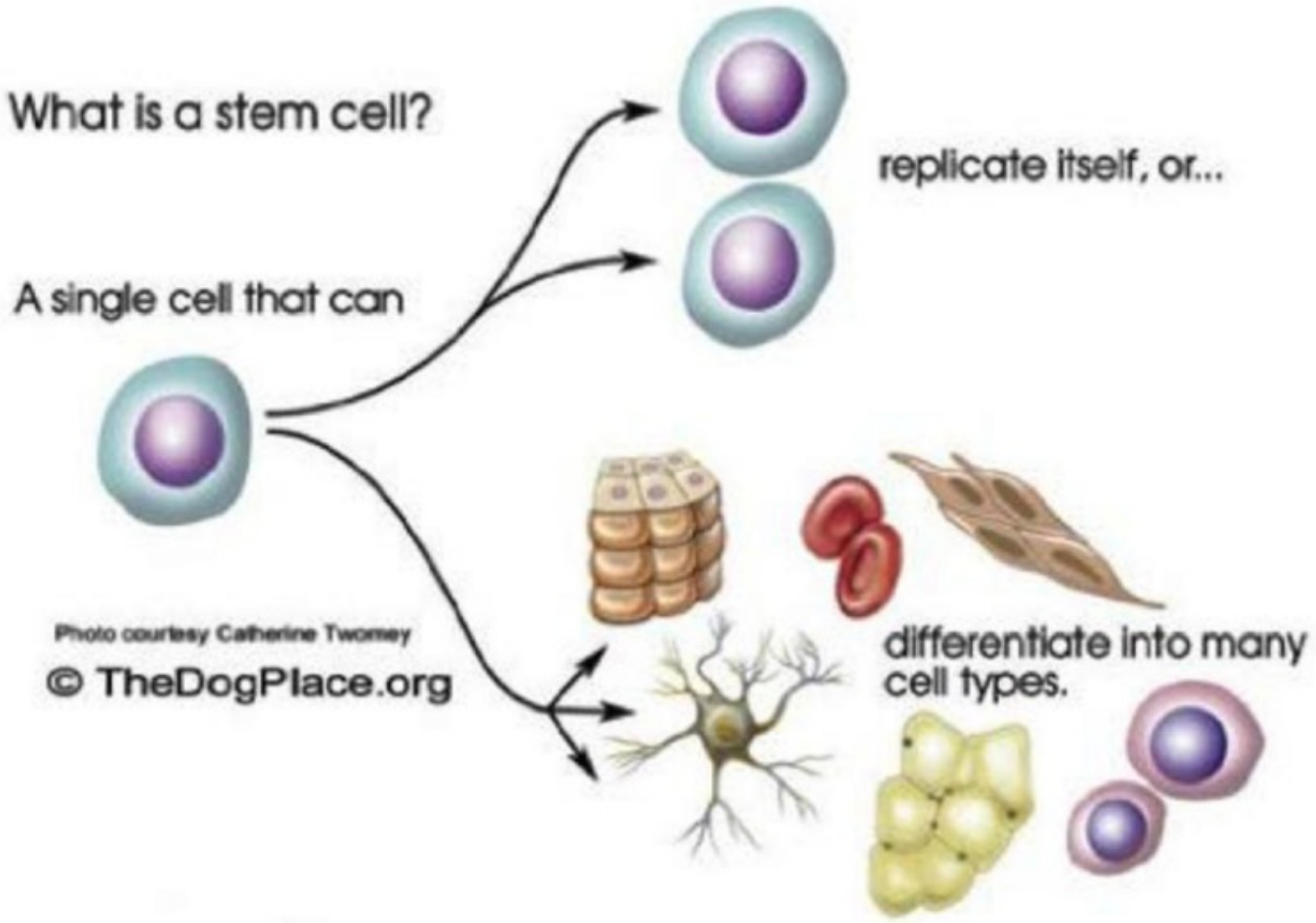
What is Regenerative medicine?

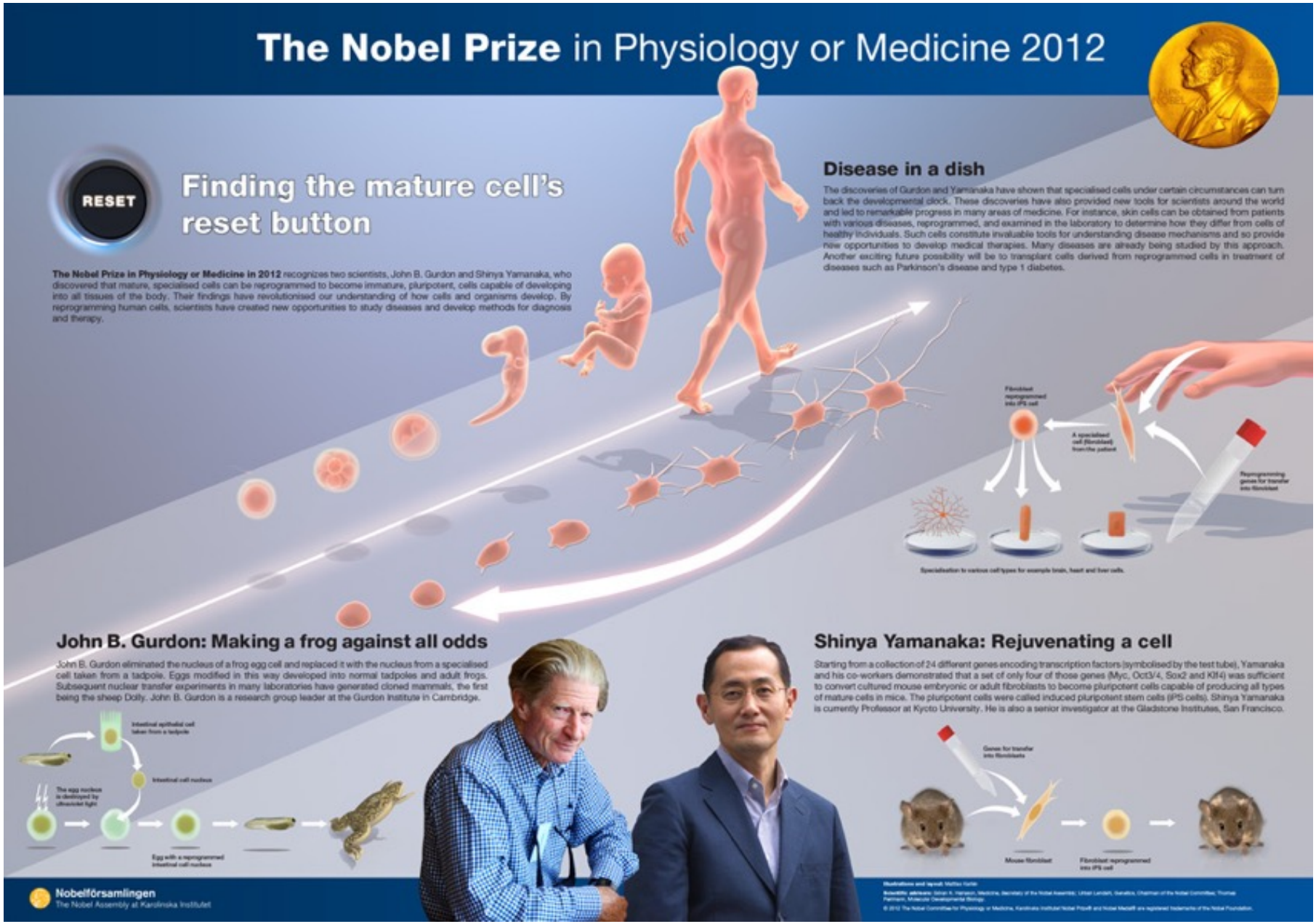
Regenerative medicine triggers and instructs the healing powers of our own bodies to restore diseased tissue and organs and/or prevent degeneration

Trauma

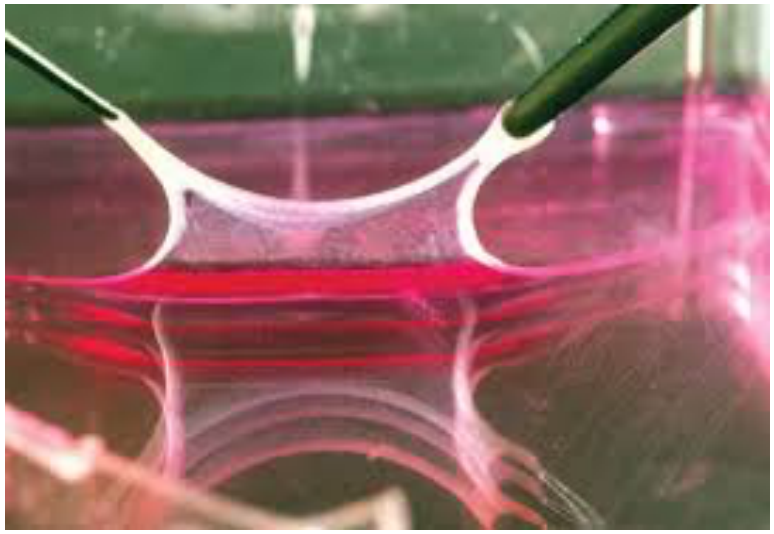
Chronic


Locations of Somatic Stem Cells
in the body
brain
teeth
skin
blood vessels
skeletal muscle
heart
liver
bone marrow
peripheral blood
gut

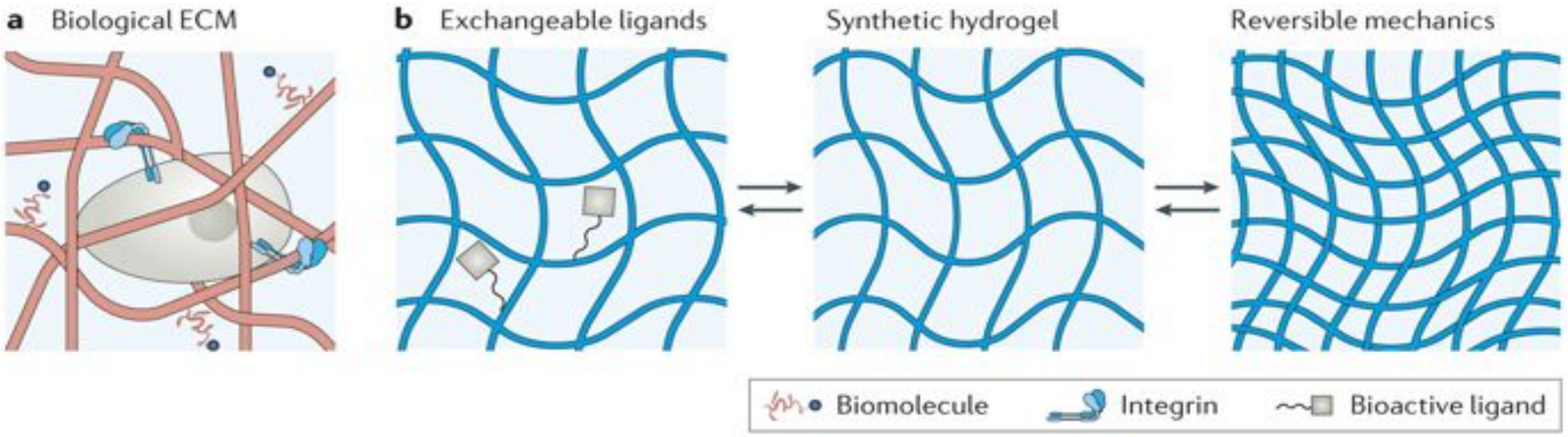

What is a stem cell?
A single cell that can
replicate itself, or...
differentiate into many cell types.
Photo courtesy Catherine Twomey
© TheDogPlace.org

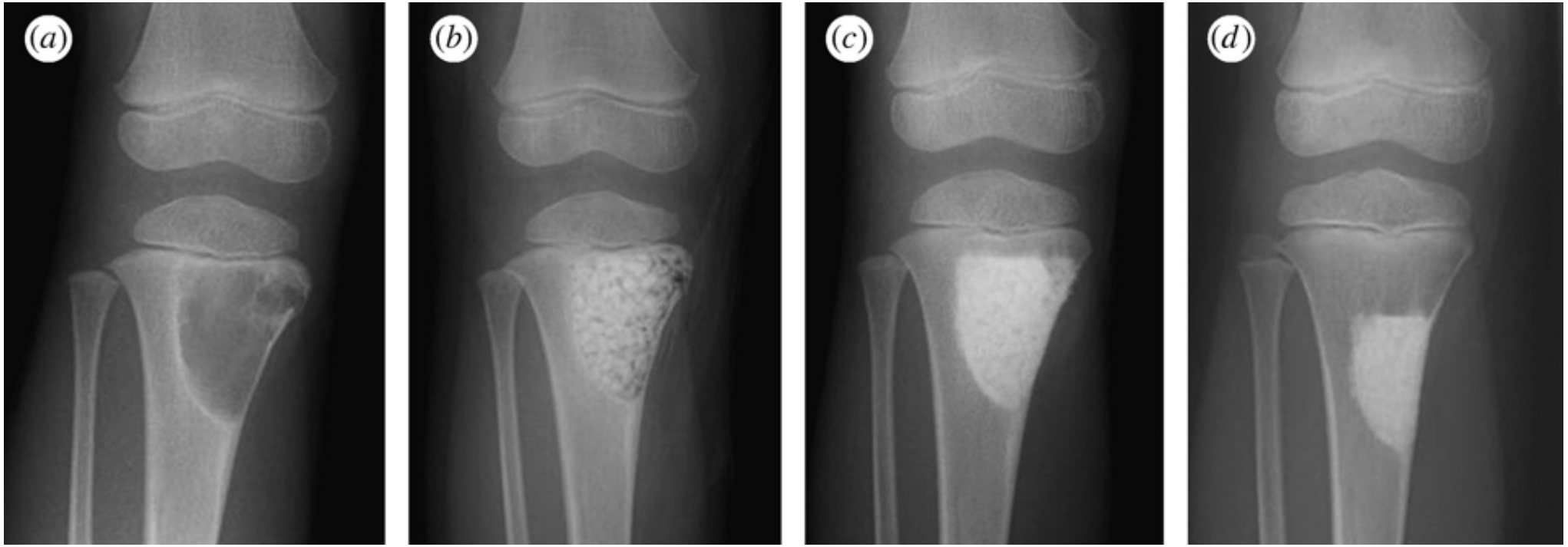

The Nobel Prize in Physiology or Medicine 2012
RESET
Finding the mature cell's reset button
The Nobel Prize in Physiology or Medicine in 2012 recognizes two scientists, John B. Gurdon and Shinya Yamanaka, who discovered that mature, specialised cells can be reprogrammed to become immature, pluripotent, cells capable of developing into all tissues of the body. Their findings have revolutionised our understanding of how cells and organisms develop. By reprogramming human cells, scientists have created new opportunities to study diseases and develop methods for diagnosis and therapy.
Disease in a dish
The discoveries of Gurdon and Yamanaka have shown that specialised cells under certain circumstances can turn back the developmental clock. These discoveries have also provided new tools for scientists around the world and led to remarkable progress in many areas of medicine. For instance, skin cells can be obtained from patients with various diseases, reprogrammed, and examined in the laboratory to determine how they differ from cells of healthy individuals. Such cells constitute invaluable tools for understanding disease mechanisms and so provide new opportunities to develop medical therapies. Many diseases are already being studied by this approach. Another exciting future possibility will be to transplant cells derived from reprogrammed cells in treatment of diseases such as Parkinson's disease and type 1 diabetes.
John B. Gurdon: Making a frog against all odds
John B. Gurdon eliminated the nucleus of a frog egg cell and replaced it with the nucleus from a specialised cell taken from a tadpole. Eggs modified in this way developed into normal tadpoles and adult frogs. Subsequent nuclear transfer experiments in many laboratories have generated cloned mammals, the first being the sheep Dolly. John B. Gurdon is a research group leader at the Gurdon Institute in Cambridge.
Shinya Yamanaka: Rejuvenating a cell
Starting from a collection of 24 different genes encoding transcription factors (symbolised by the test tube), Yamanaka and his co-workers demonstrated that a set of only four of those genes (Myc, Oct3/4, Sox2 and Klf4) was sufficient to convert cultured mouse embryonic or adult fibroblasts to become pluripotent cells capable of producing all types of mature cells in mice. The pluripotent cells were called induced pluripotent stem cells (iPS cells). Shinya Yamanaka is currently Professor at Kyoto University. He is also a senior investigator at the Gladstone Institutes, San Francisco.
Nobelförsamlingen
The Nobel Assembly at Karolinska Institutet

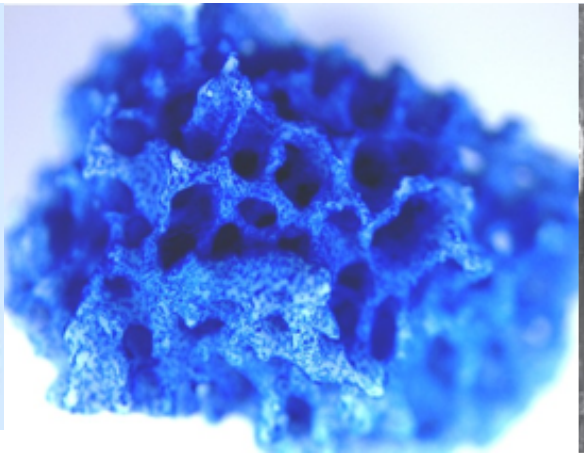
Cells

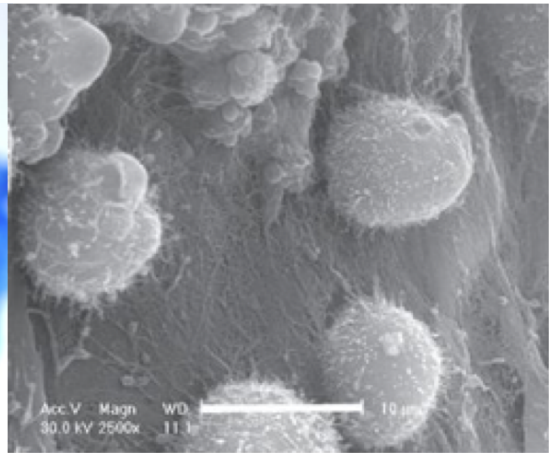


Biomaterials



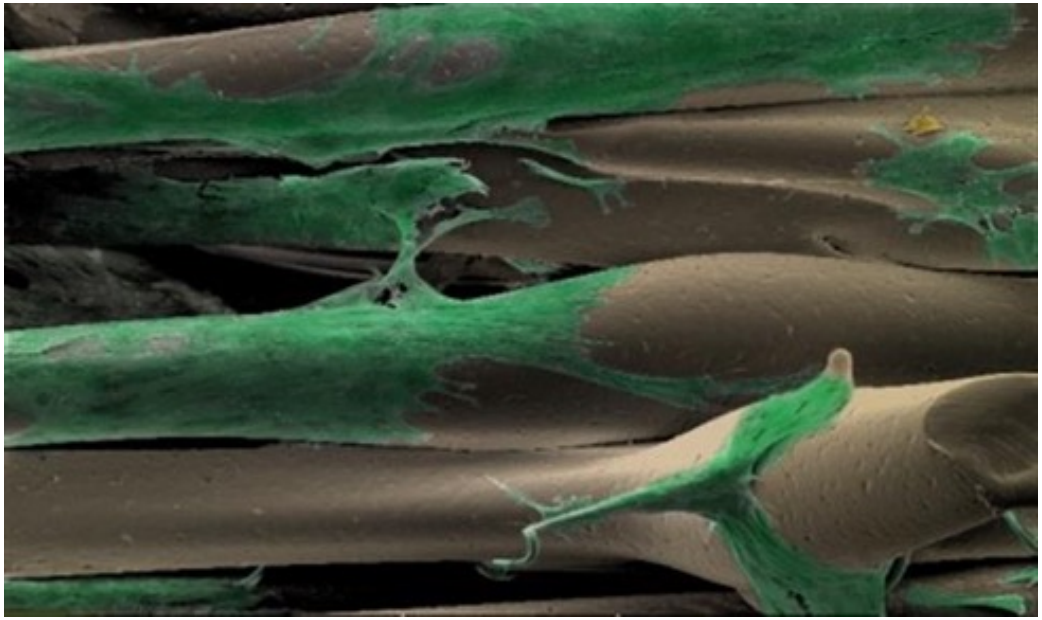






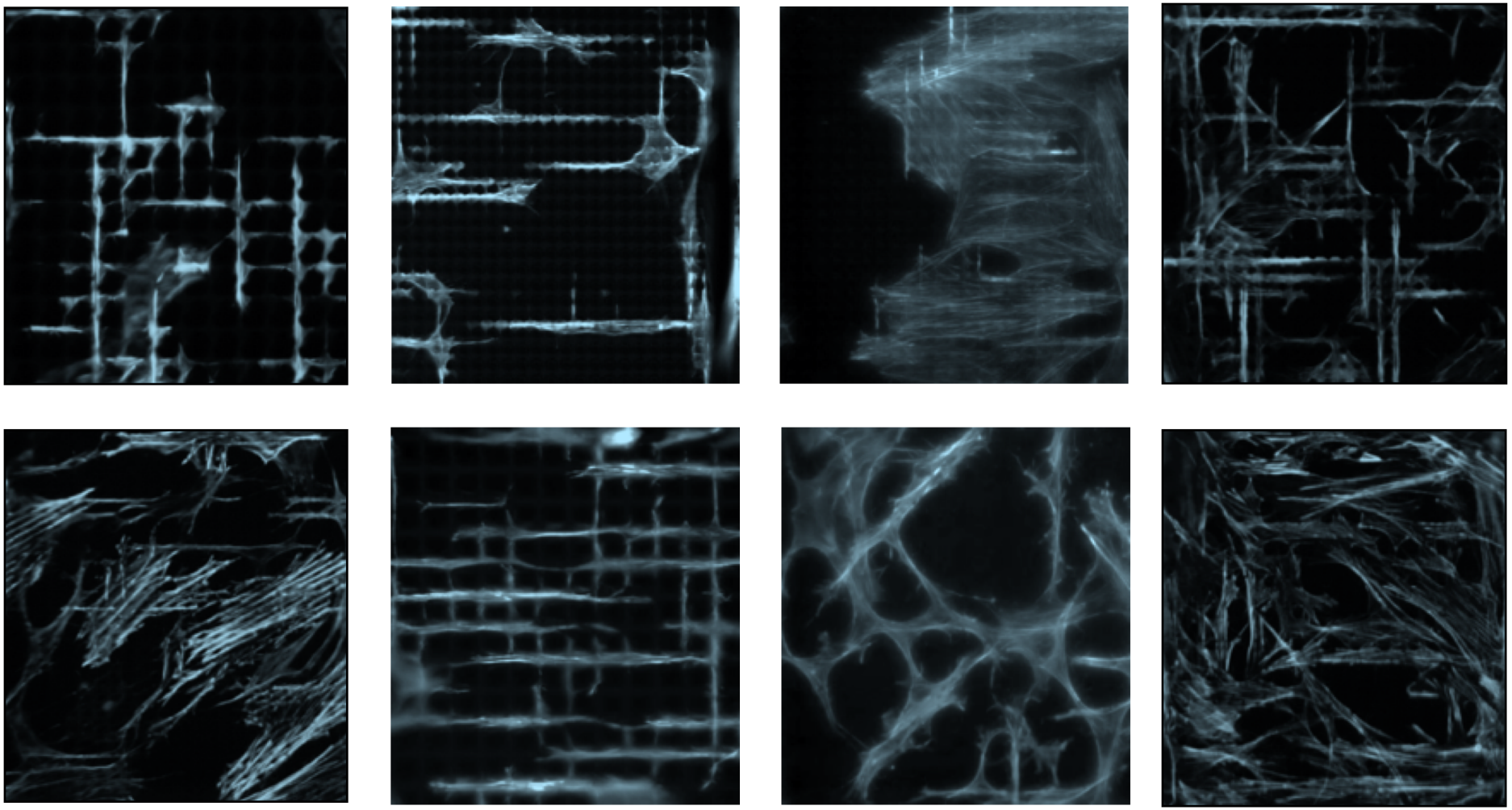
MERLN – Institute for Technology Inspired Regenerative Medicine

➢ Correct surface properties

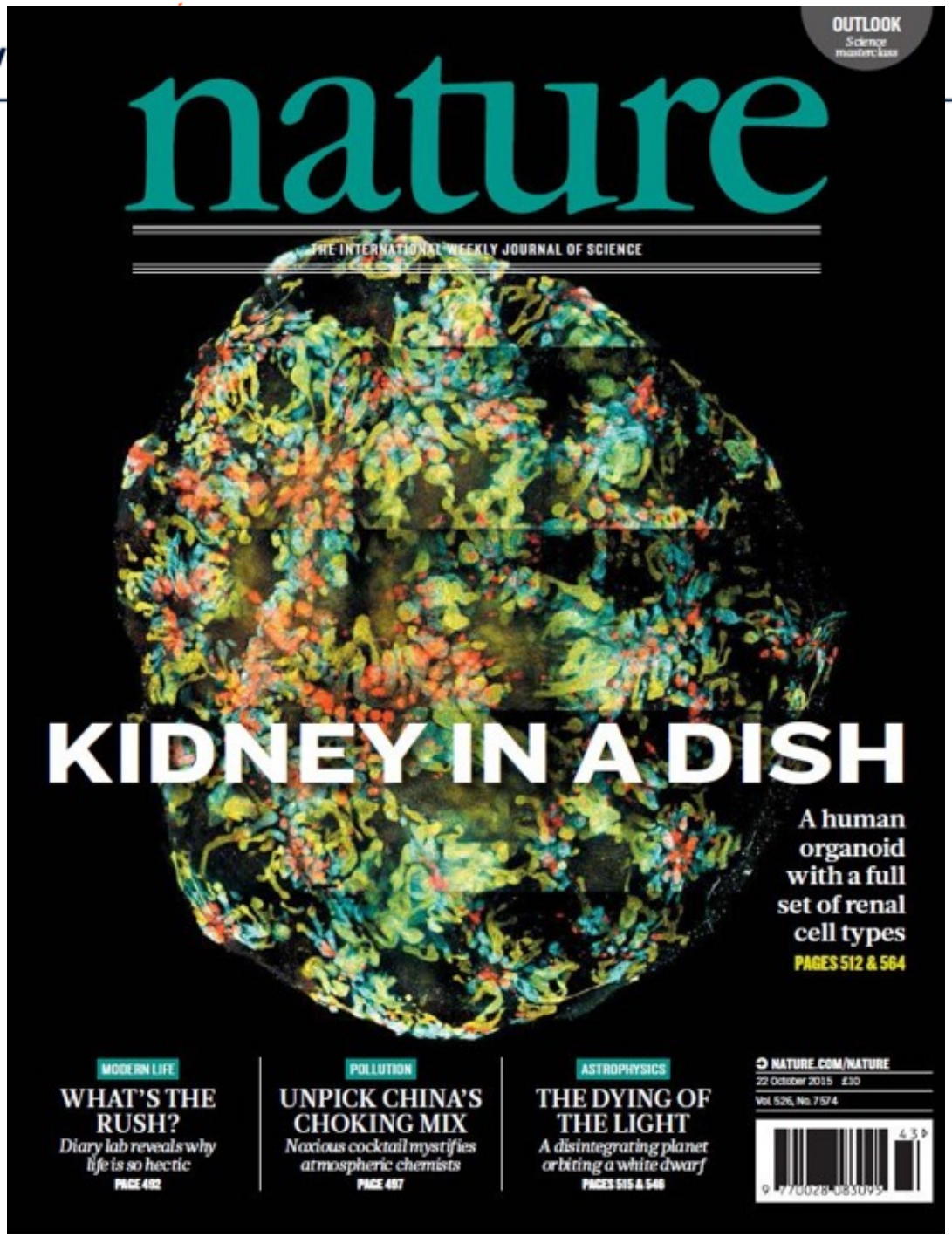


Cell-material interactions

➢ Intelligent design



Additive manufacturing


OUTLOOK
Science masterclass
nature
THE INTERNATIONAL WEEKLY JOURNAL OF SCIENCE
KIDNEY IN A DISH
A human organoid with a full set of renal cell types
PAGES 512 & 564
MODERN LIFE
WHAT'S THE RUSH?
Diary lab reveals why life is so hectic
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POLLUTION
UNPICK CHINA'S CHOKING MIX
Noxious cocktail mystifies atmospheric chemists
PAGE 497
ASTROPHYSICS
THE DYING OF THE LIGHT
A disintegrating planet orbiting a white dwarf
PAGES 515 & 548
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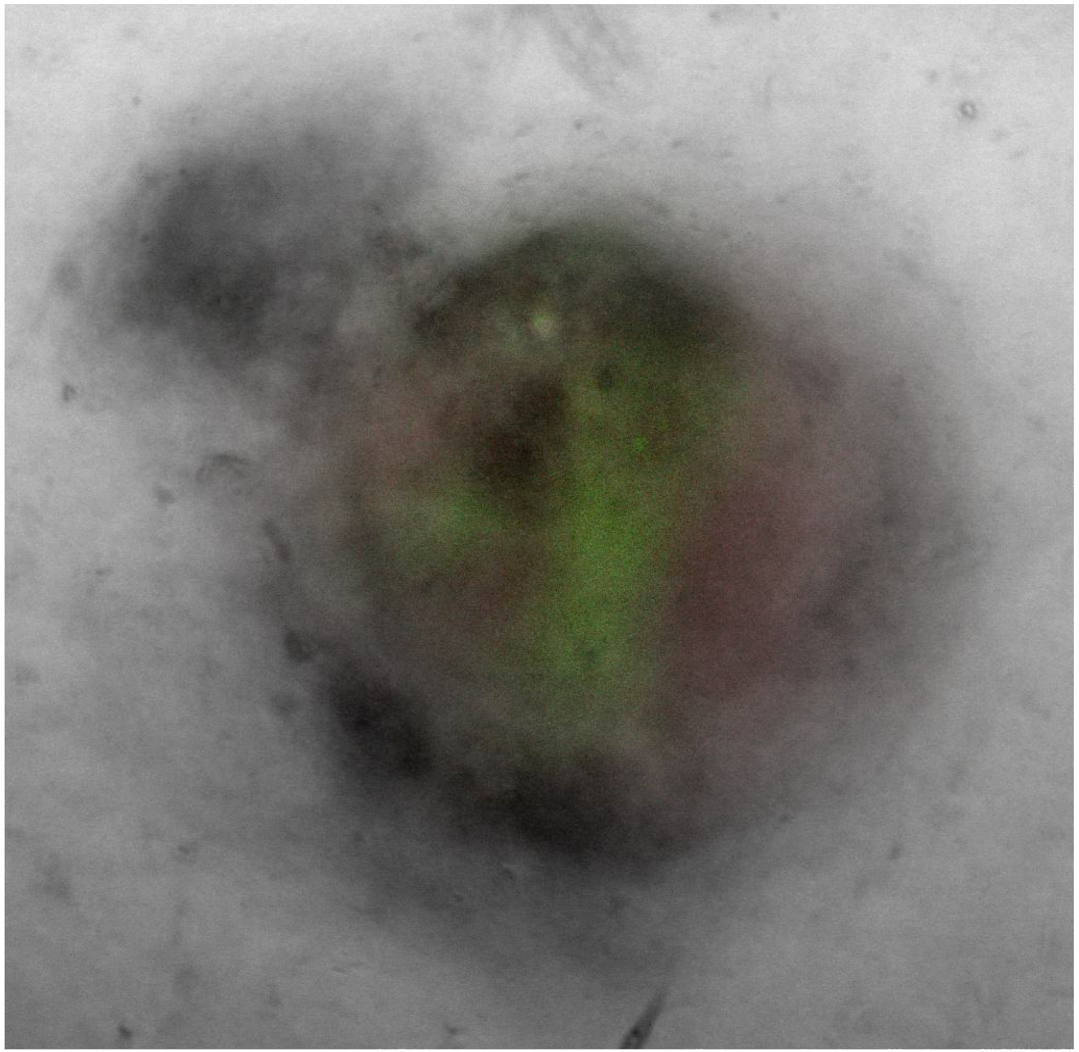
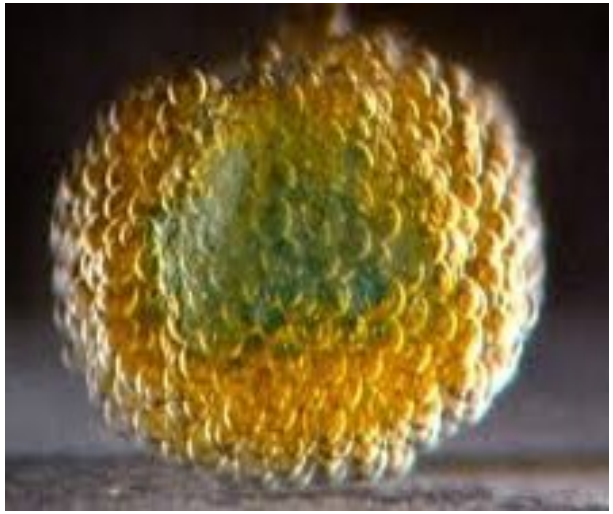
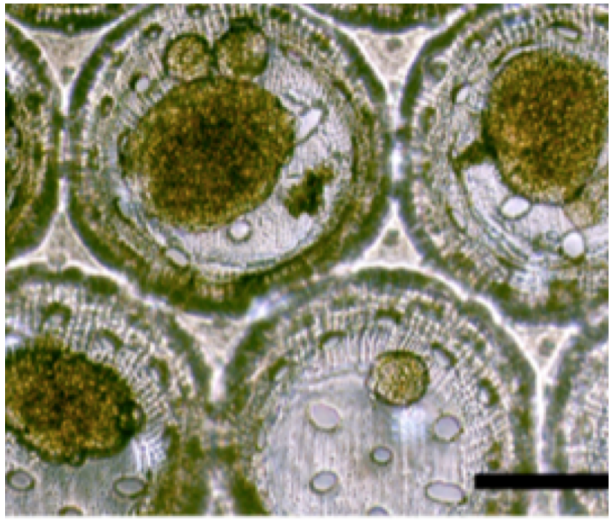
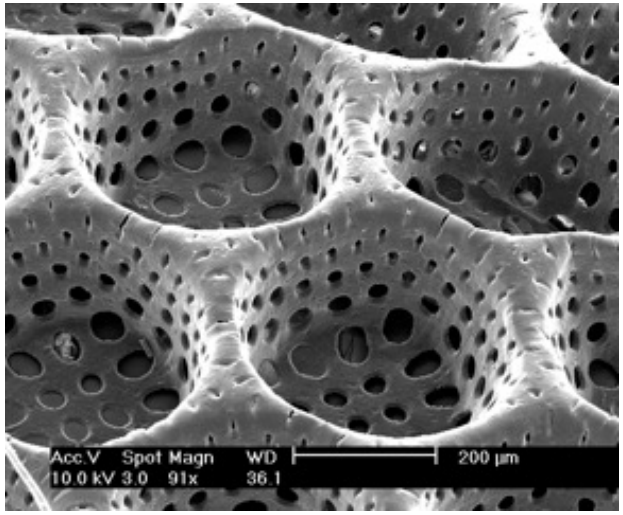
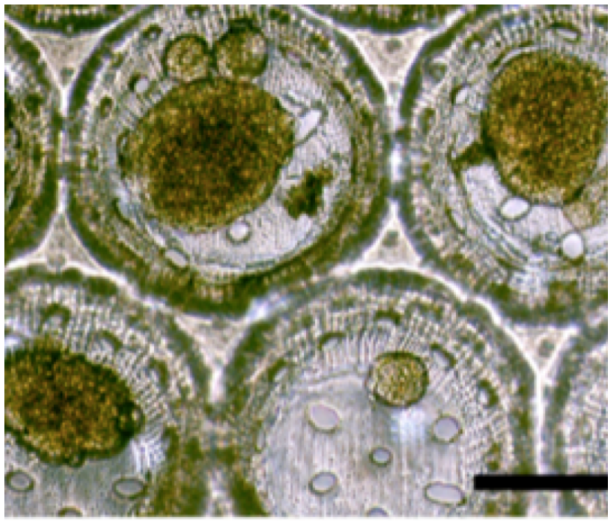
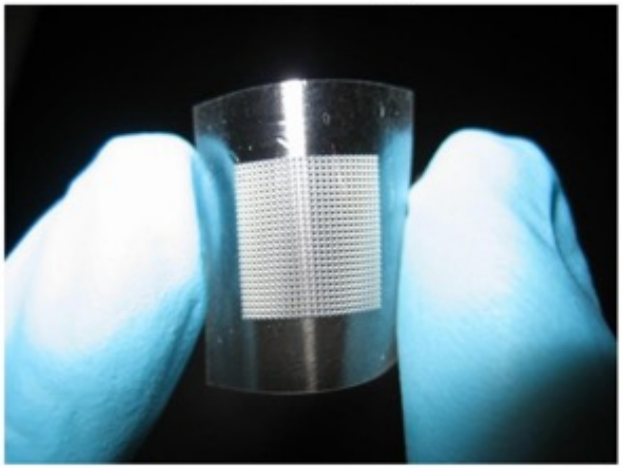




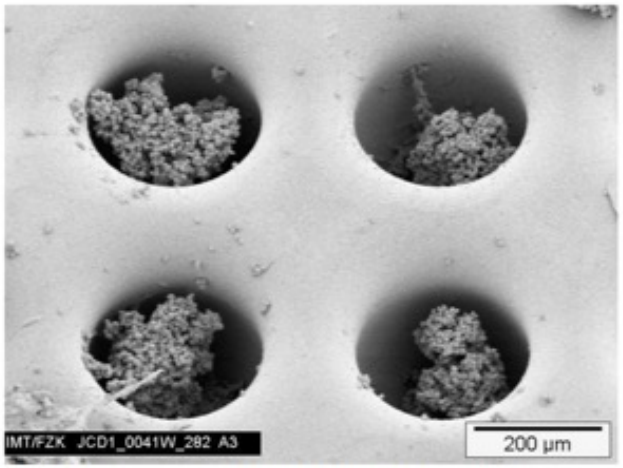








… from 50 µm thin PC film comprising 625 wells with diameter and depth of ~300 µm

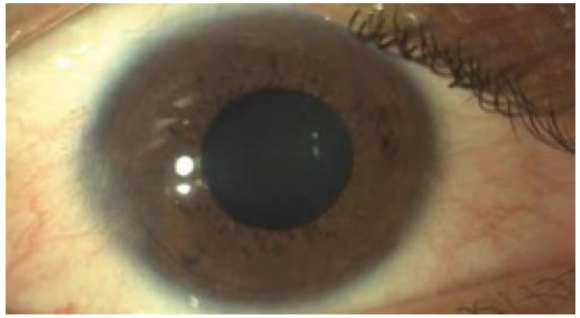


HepG2 hepatocellular carcinoma cells cultured in collagenized microwells

Clinical example: Holoclar

Before..

After..

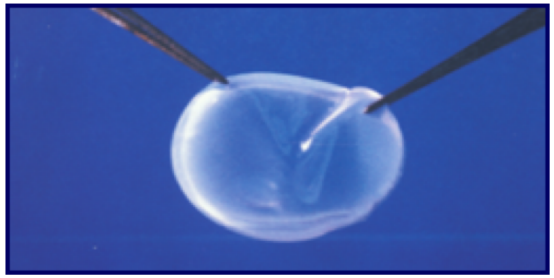


- Eye one of the few organs with proven stem cell therapy
- corneal regeneration

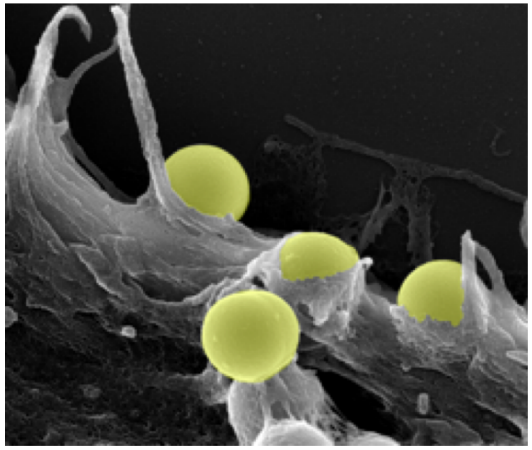
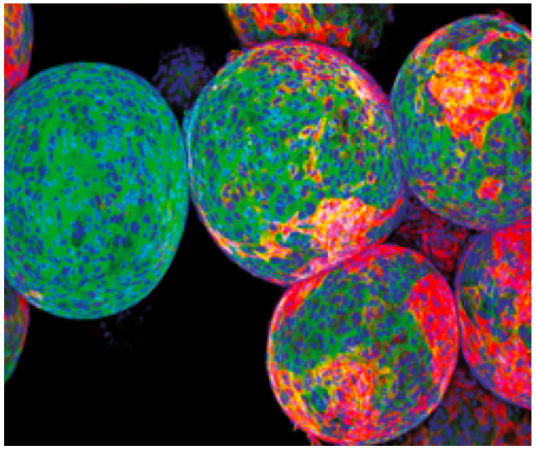
Stem cells..

+

material..



Interdisciplinary!!

Engineers **Chemists**

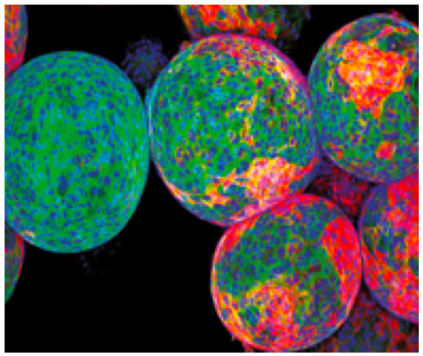
Biologists **Clinicians**

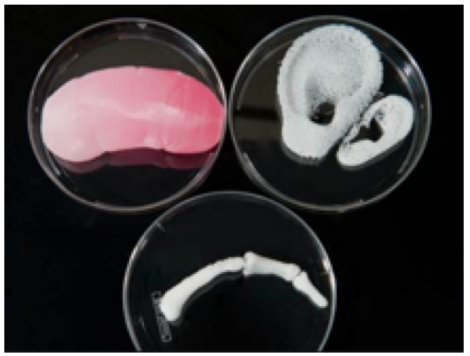
Track content

Block 1: The science and technology of regenerative medicine

Coordinators: Sabine van Rijt/ Aurelie Carlier

s.vanrijt@maastrichtuniversity.nl
a.carlier@maastrichtuniversity.nl





Block 1: The science and technology of regenerative medicine

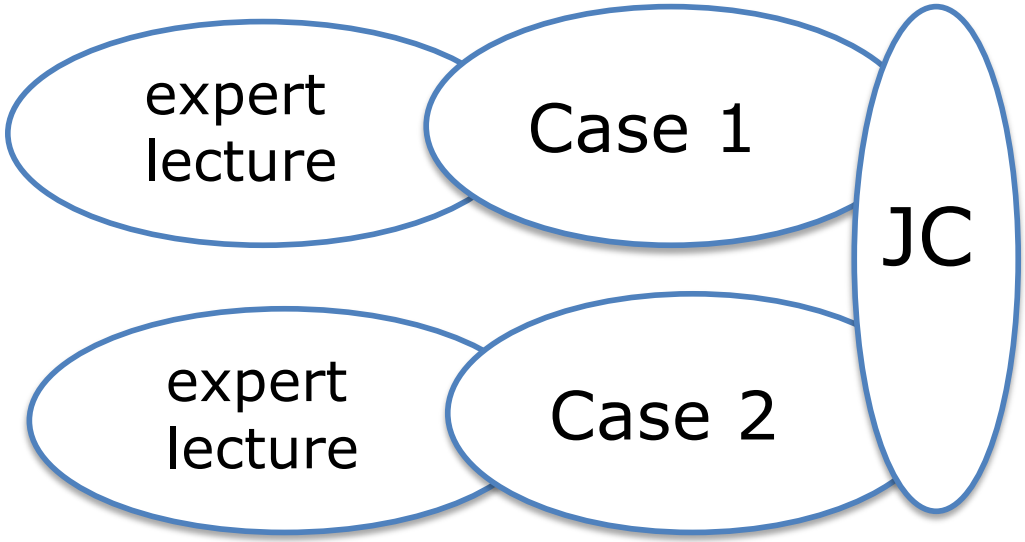
Helicopter view on RM
Laying foundations for later studies

1 topic per week:

Wound healing
Stem cells
Organoids
Biomaterials
Scaffold design and manufacturing
Organ-on-a-chip

Educational formats: *lectures, problem based learning, journal clubs, debating, assignments.*

Assessment: *exam, presentation, writing*



Example:
How to make a synthetic nephron?

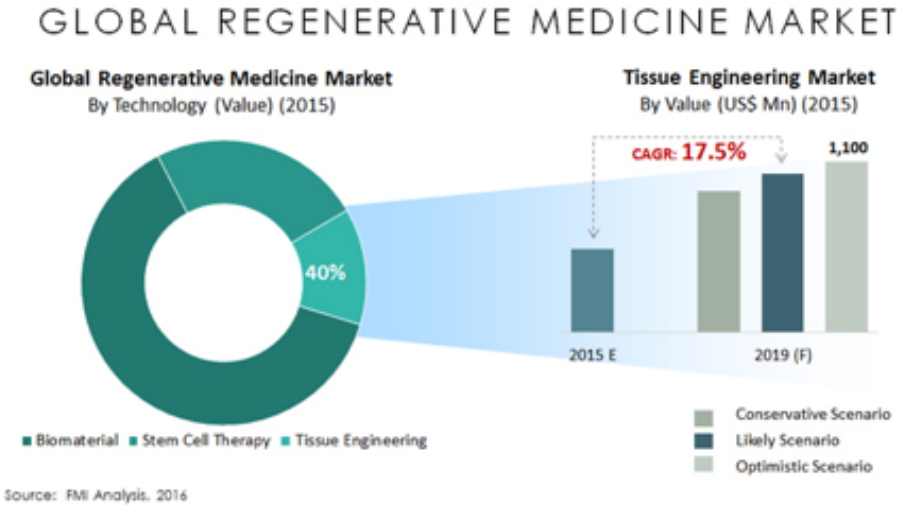
? Cell source
? Material
? Technique

Block 2: Translating therapies into the clinic and onto the market

Coordinators: Aart van Apeldoorn/Marjolein Caron

a.vanapeldoorn@maastrichtuniversity.nl
marjolein.caron@maastrichtuniversity.nl

How to translate your regenerative medicine ideas into clinical reality?



What is the course about?

It's **about you** and your project team members

This is your unique RM project!

It's about finding a **new** regenerative medicine **solution** for a **current clinical problem**

It's about **writing and presenting your research** strategy in a proposal and learning everything about using and translating RM knowledge into a clinical solution

Clinical cases

1.Cranio-Maxillofacial Surgery

David Koper

2.Opthalmology

Mor Dickman

3.Orthopedics

Pieter Emans

4.Experimental Surgery

Nicole Bouvy

5.Type 1 diabetes

Aart van Apeldoorn

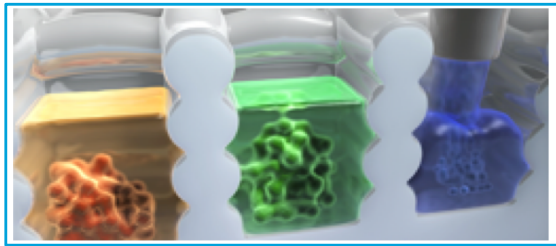
Each group **will work on one clinical case** to develop a new regenerative medicine strategy

We'll **invite companies** and **valorisation experts** to share first hand knowledge on how to bring a regenerative medicine product to the market

XELTIS

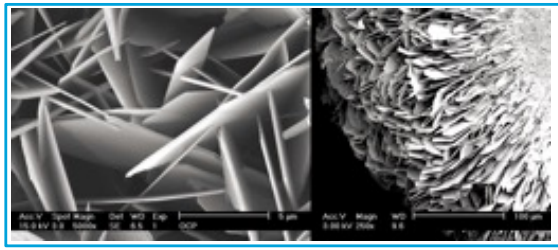
year 2: 1 year research project

MERLN- Who are we?



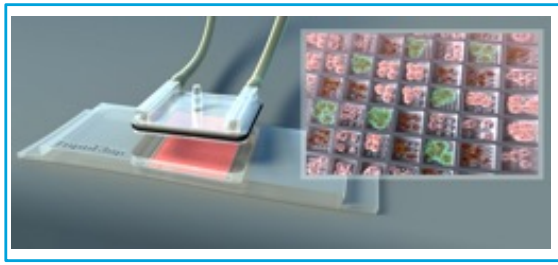
Complex Tissue Regeneration (CTR)

Lorenzo Moroni
Clemens van Blitterswijk
Matthew Baker
Paul Wieringa
Carlos Domingues Mota



Instructive Biomaterials Engineering (IBE)

Pamela Habibovic
Sabine van Rijt
Elizabeth Rosado Balmayor
Stefan Giselbrecht
Roman Truckenmüller



Cell Biology - Inspired Tissue Regeneration (cBITE)

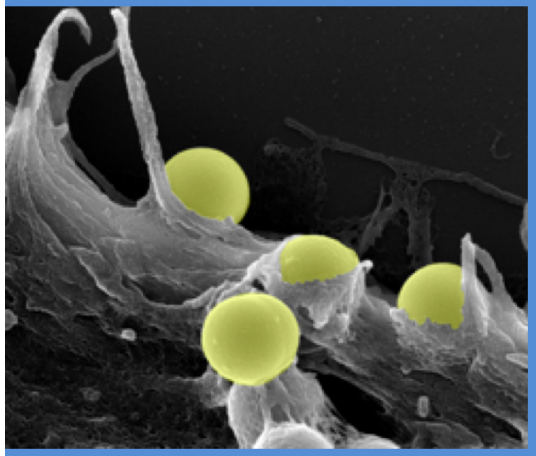
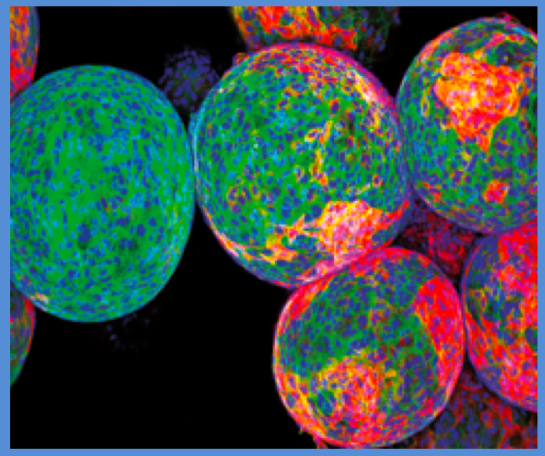
Martijn van Griensven
Aurèlie Carlier
Vanessa LaPointe
Aart van Apeldoorn

Why choose this specialization?

Maastricht University Leading in Learning! **Biomedical sciences**

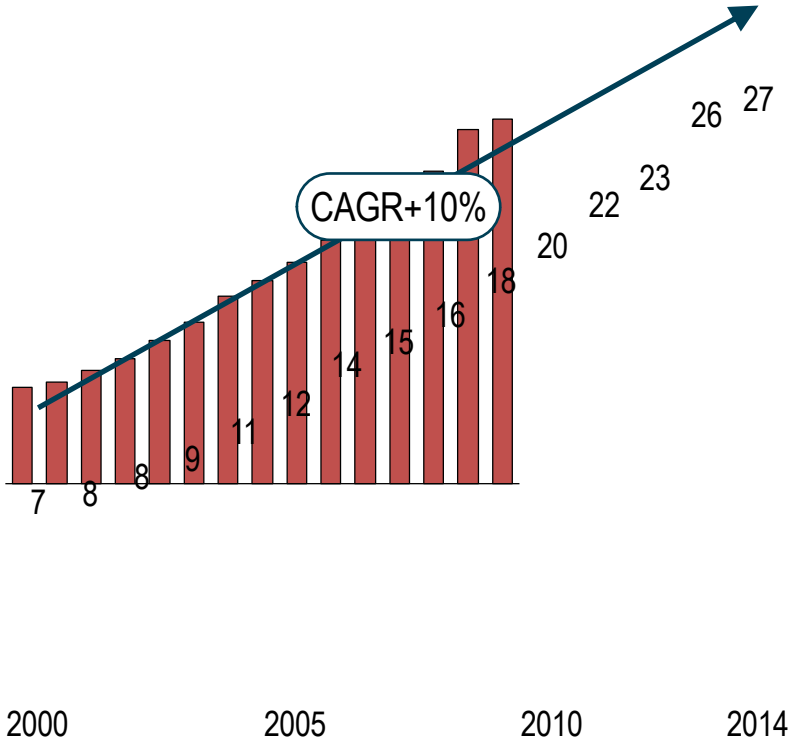
Become **a pioneer** in the field by receiving an interdisciplinary training combining **cell biology, biomaterial sciences** and **engineering** at Maastricht University

- ✓ Focus on problem solving and hands-on training
- ✓ Get translational insights; close collaboration with the hospital and SMEs
- ✓ Professional training in product development
- ✓ Become prepared to work in an interdisciplinary team

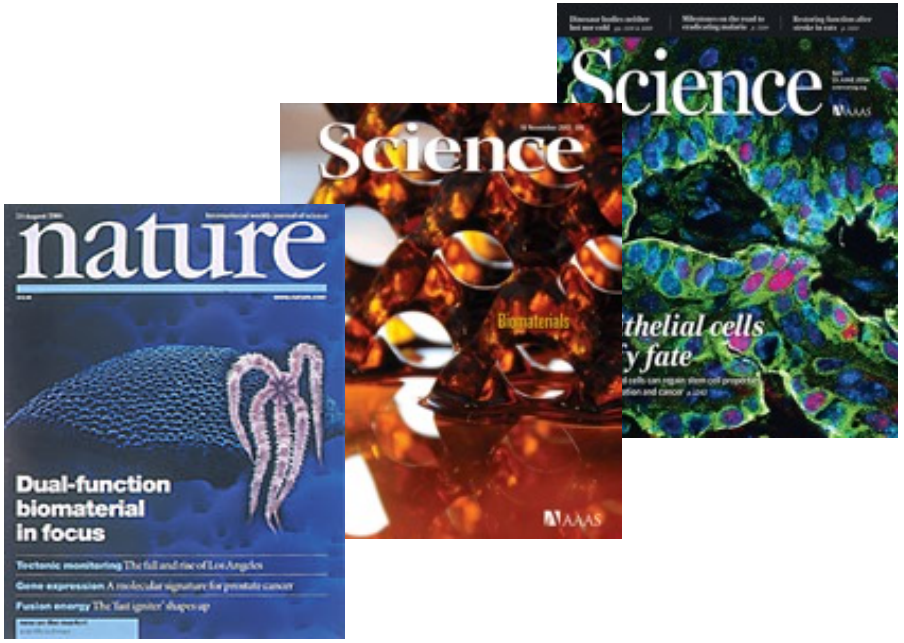
Regenerative medicine is a booming scientific field

Number of regenerative medicine publications worldwide ['000]



Stem Cell Scientists Awarded Nobel Prize in Physiology and Medicine

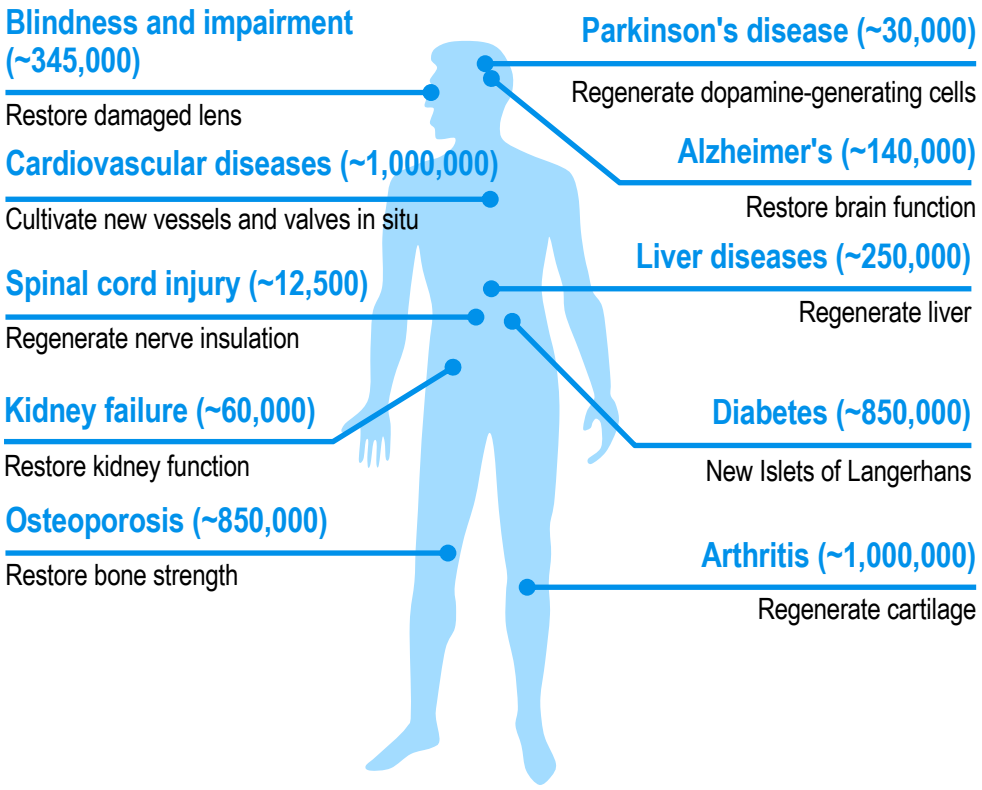
In what researchers view as validation of the field, the Nobel committee on Monday recognized pioneering contributions to stem cell science by John Gurdon and Shinya Yamanaka



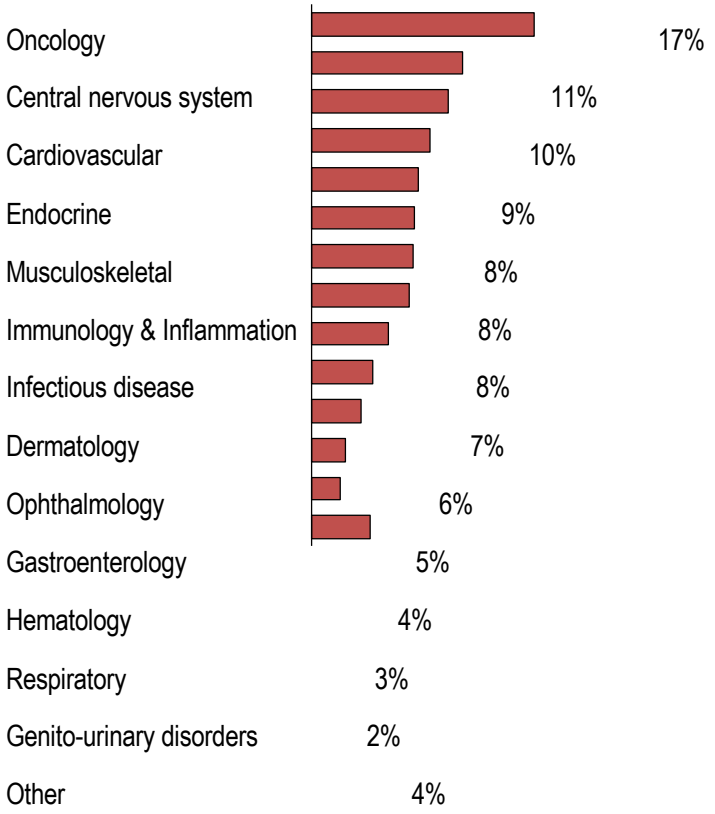
Source: Scopus (keywords: "regenerative medicin*", "stem cell*", "tissue engineering"; articles); Science; Nature; Time

Regenerative medicine has the potential to cure many patients

Promise of regenerative medicine solutions for patients (# of patients in NL)



Application area of regenerative medicine companies [% of total, world]



Source: Alliance Regenerative Medicine (2015); Diabetes Fonds; Cijfers over Kanker; Dwarslaesie Fonds; Nierstichting; Hartstichting; Osteoporose Stichting; Reumafonds; Retina Nederland

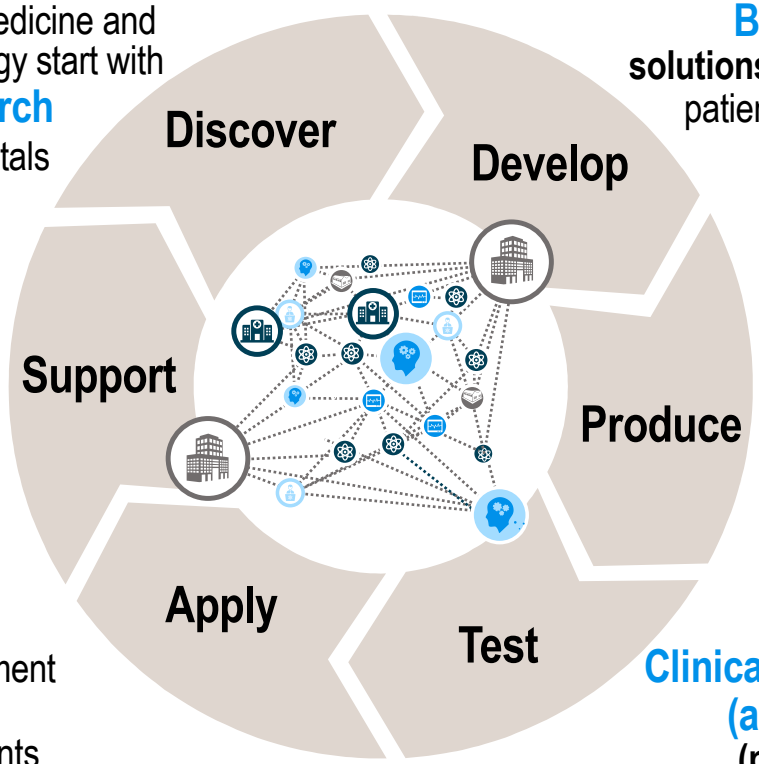
Regenerative medicine promises the development of a new, innovative, knowledge intensive industrial sector

New sector

New concepts for regenerative medicine and production/testing/tooling technology start with frontier science at excellent **research institutes** and (associated) hospitals

High-tech companies develop and supply **critical technologies/tools** for regenerative medicine development, like imaging tools to stratify patients and monitor results, and analytical equipment and services

(Specialized) hospitals implement and apply regenerative medicine solutions, **delivering** them to patients



Biotech companies develop **real solutions for patients**, and deliver them to patients through viable business models

Innovative producers provide new production services and technology for **affordable and large-scale production** of regenerative materials, stem cells and RM devices; e.g. bioreactors, 3D printing and high-throughput technologies

Clinical research organizations and (academic) hospitals support the **(pre)clinical testing** of regenerative solutions and regulatory support services