

Willkommen
Welcome
Bienvenue



Empa Postdocs-II & PSI-FELLOW II-3i RETREAT 2018

Hydrogels for Tissue Engineering of Microvessels

Kongchang Wei
21/09/18

Thank you!



The EMPAPOSTDOCS-II programme has received funding from the European Union's Horizon 2020 research and innovation programme under the Marie Skłodowska-Curie grant agreement number 754364.



Materials Science and Technology

Biomimetic Membranes and Textiles

Supervisor: C. Toncelli@401

Collaborator: R. Markus@404

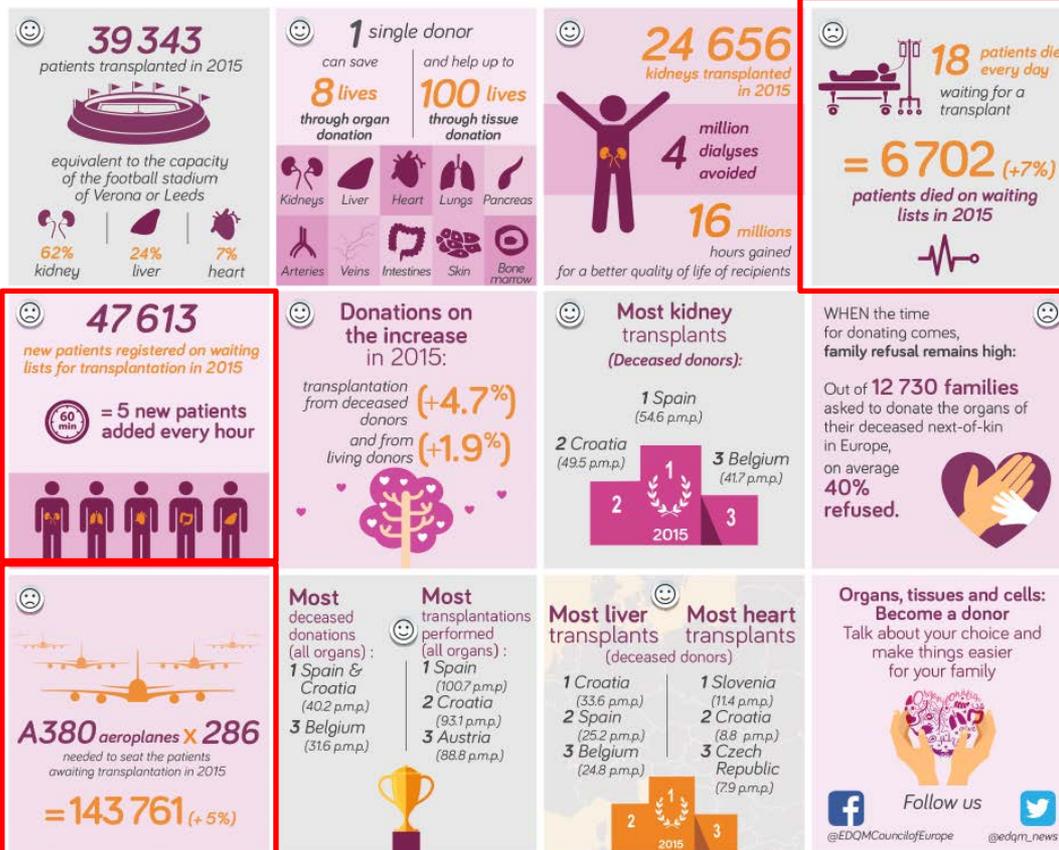
J. C. Cassano@403

Tissue Shortage (EU, 2015)

On the waiting list:

- 120 new patients added/day
- 18 patients died/day

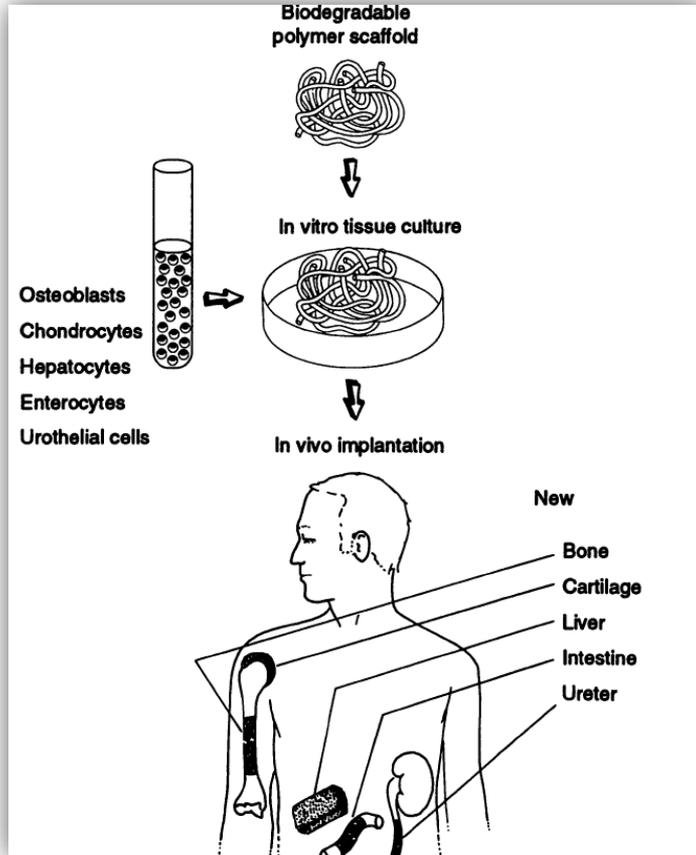
BRING BACK HOPE
to patients on waiting lists all over Europe!



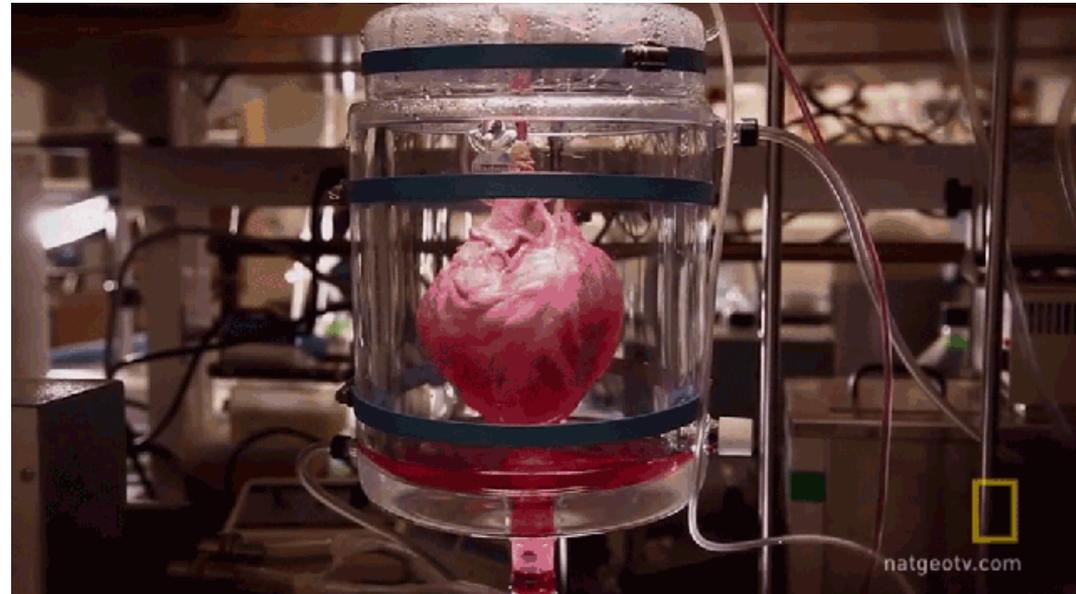
Reference Newsletter Transplant Vol. 21, N°1 Sept. 2015 / Percentages increase compared to previous year - p.m.p. stands for per million people.

Tissue Engineering

■ Artificial Tissues/Organs



How to build a beating heart?
2011, National Geographic Explorer episode

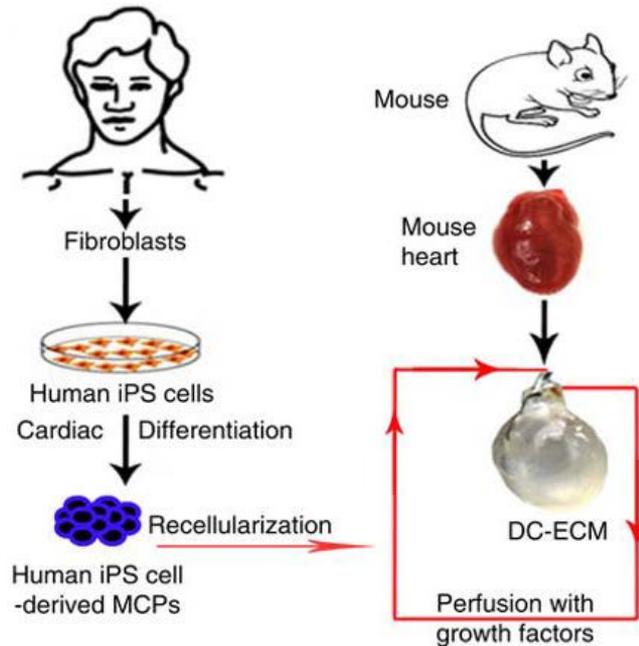


A human heart in the lab of Dr. Harald Ott
@Harvard Medical School

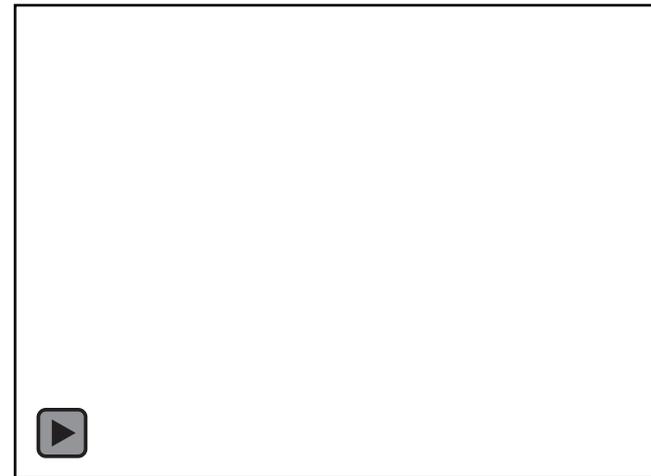
Langer, R. et. al. *Science* **1993**, 260, 920-926.

How to build a beating heart?

- We don't know yet...
- However...

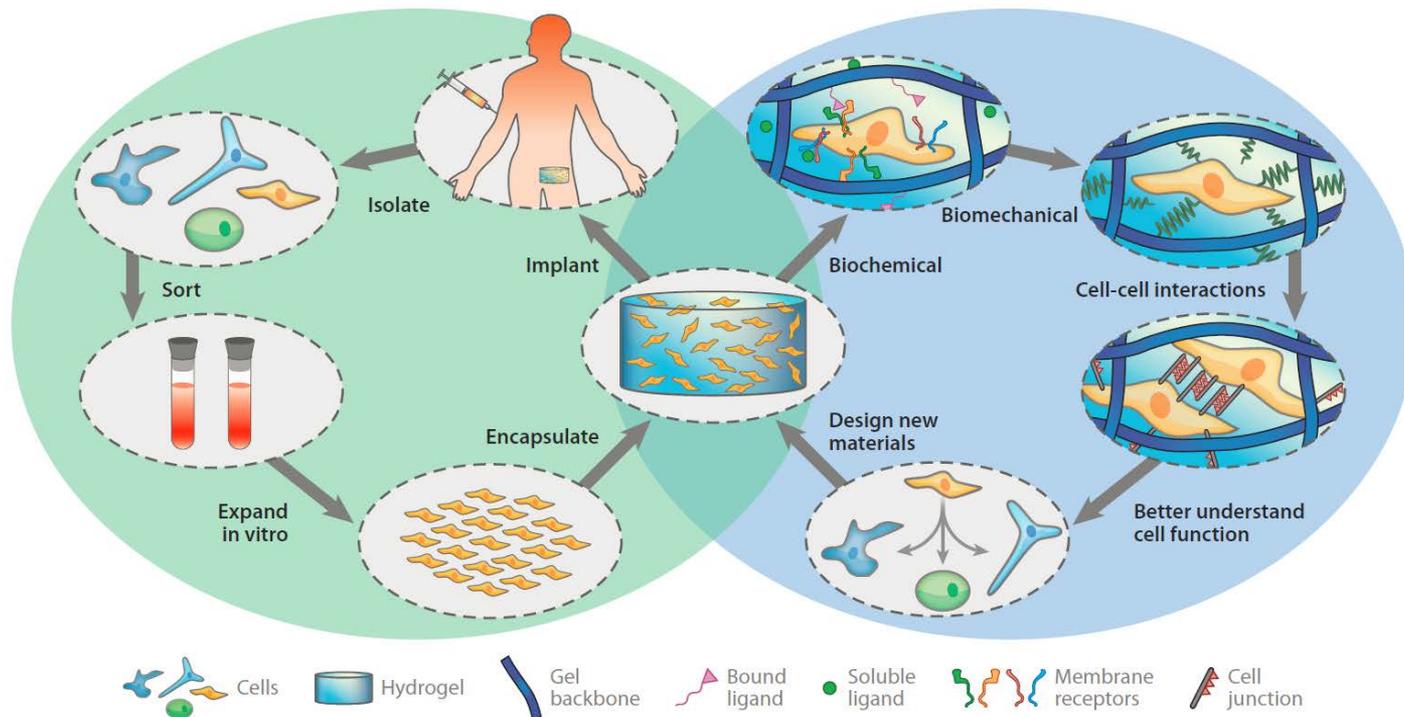


Day 20

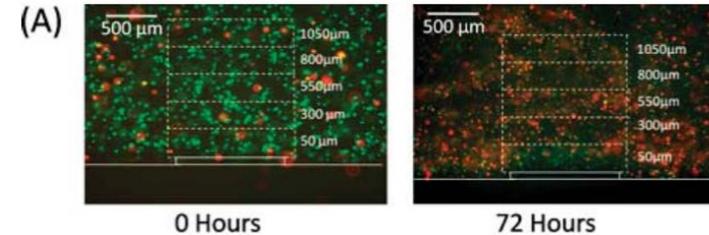
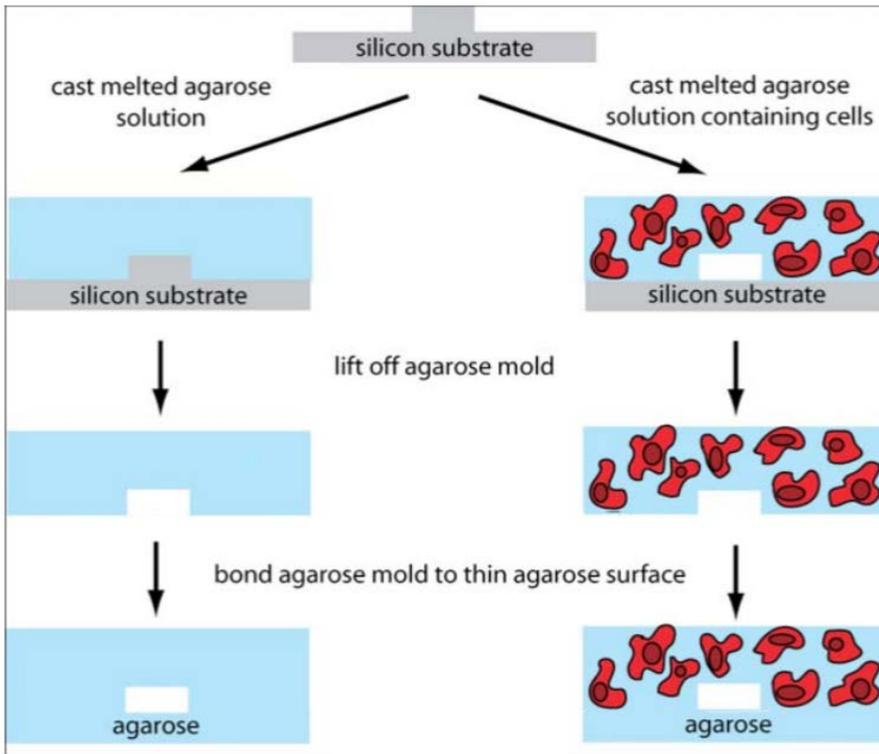


Tissue Engineering in Hydrogels

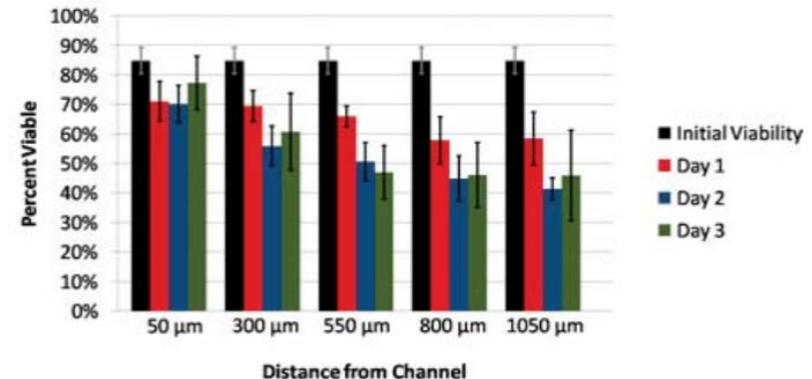
- Hydrogels—Artificial Extracellular Matrix
- No vasculature structures: poor nutrient and oxygen transportation



Distance > 0.5mm Cell life < 3days

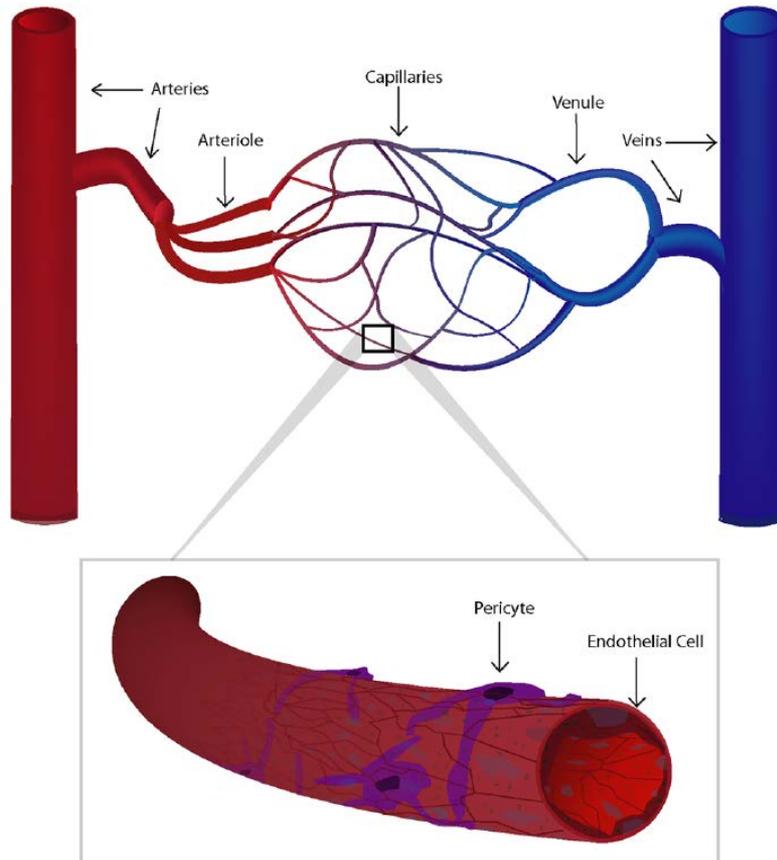


Viability vs. Distance from Channel



device fabrication, only those cells near the microfluidic channels remained viable after 3 days, demonstrating the importance of a perfused network of microchannels for delivering nutrients and oxygen to maintain cell viability in large hydrogels. Further development of this technique

Microvessel engineering in hydrogels

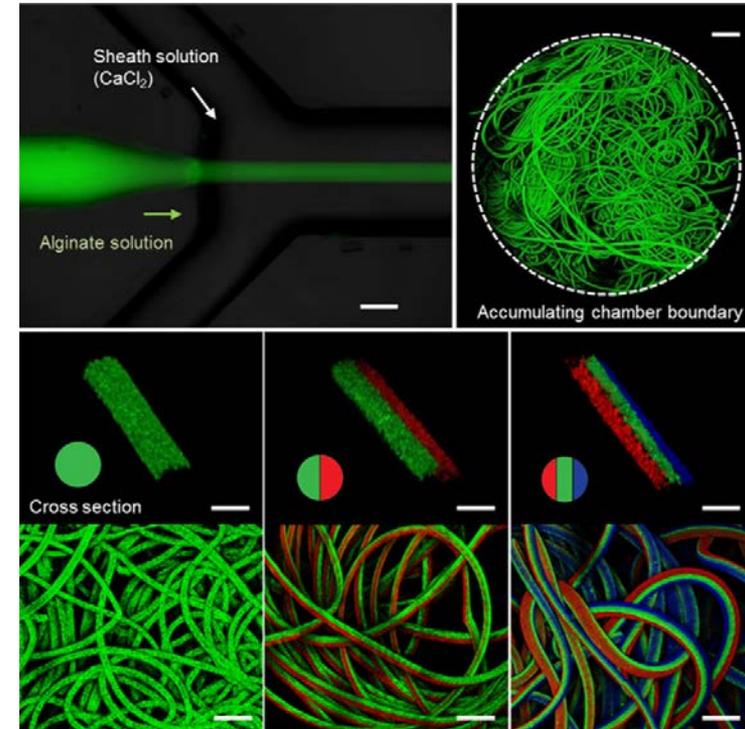
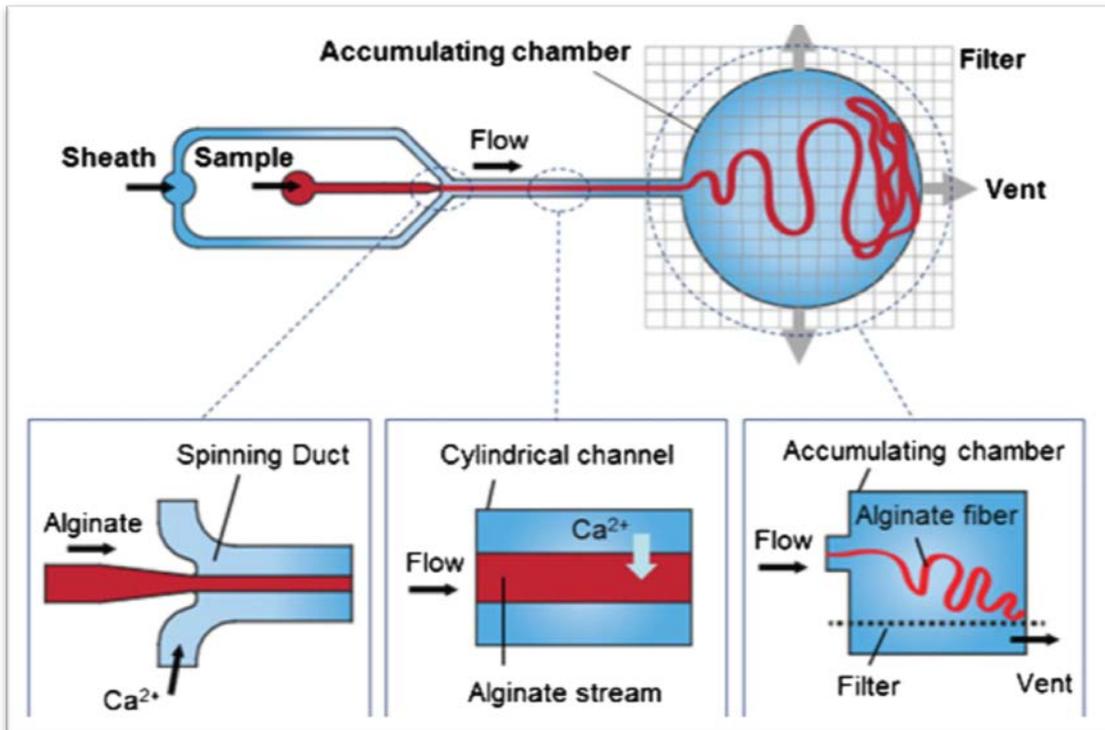


- **Not** large blood vessels
 - $> 6\text{mm}$
 - Blood transportation between organs
 - Replacement surgery
 - Autologous tissues available
 - synthetic polymer prosthetics available
 - $< 6\text{mm}$: less available autografts and synthetic prosthetics

- **But** Microvessels
 - $< 1\text{mm}$
 - Supplying nutrients and oxygen to cells within tissues
 - Replacement? No!

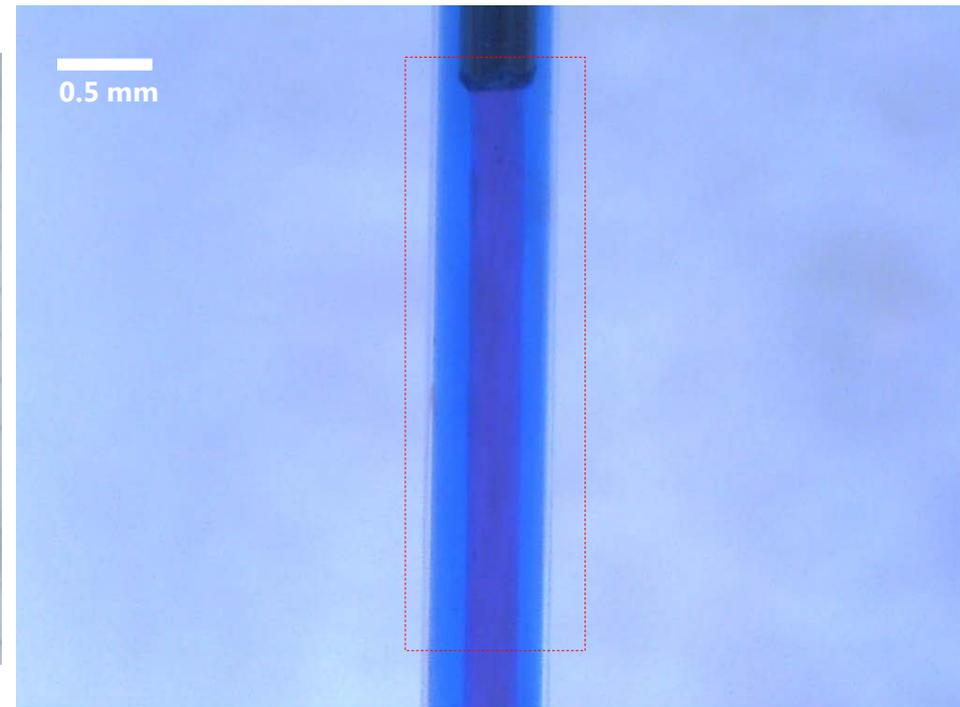
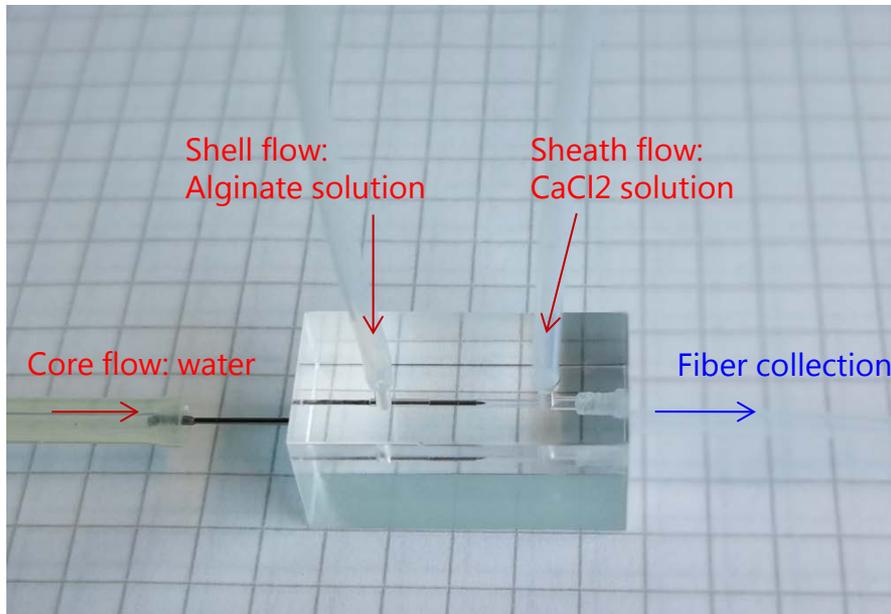
Microfluidic spinning of hydrogel fibers

- Hydrogel microfibers + Endothelial cells = microvessels ?



Microfluidic Spinning

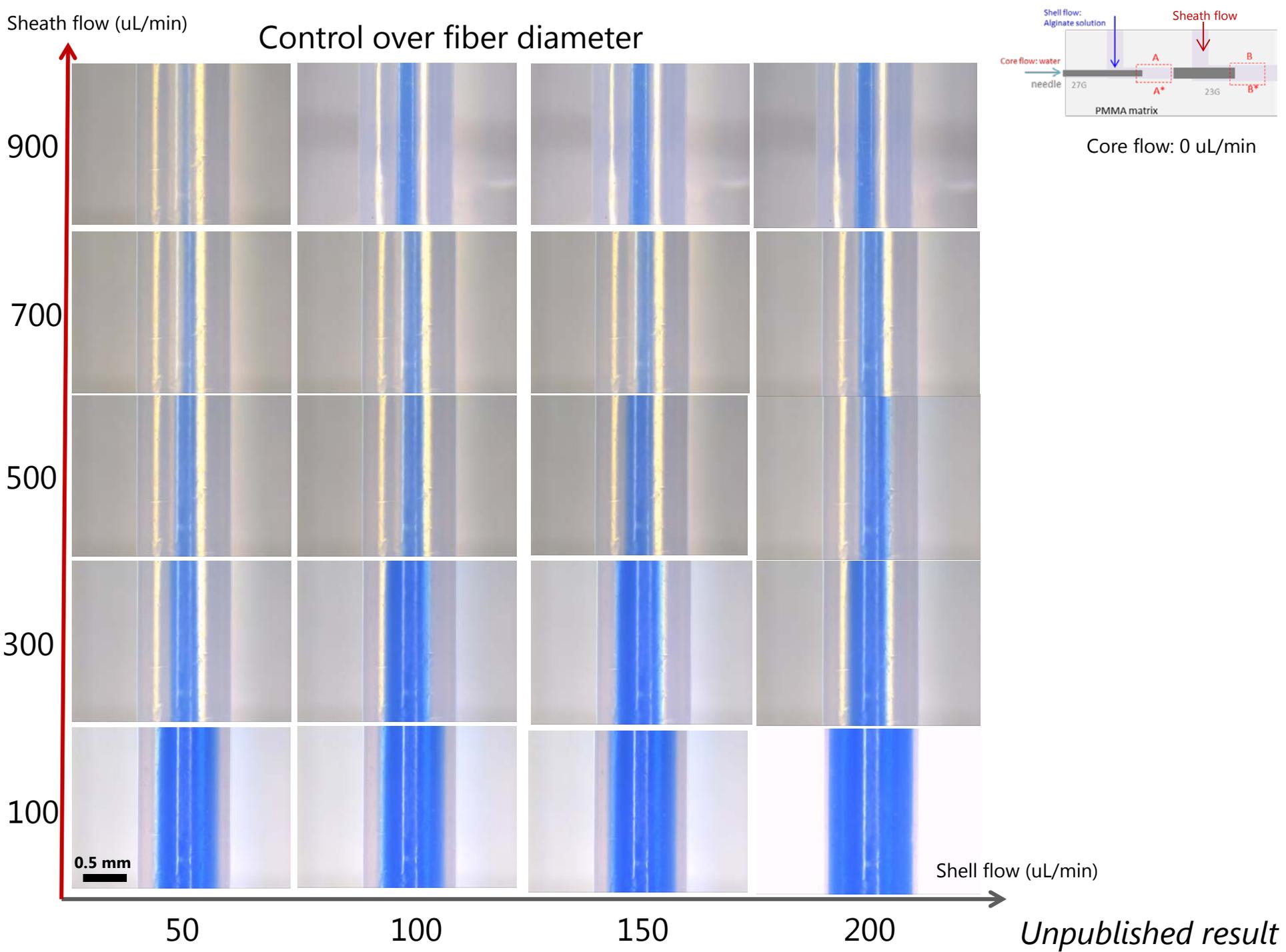
- Micro-tubular structures (microvessel templates)



Hydrogel microfibers

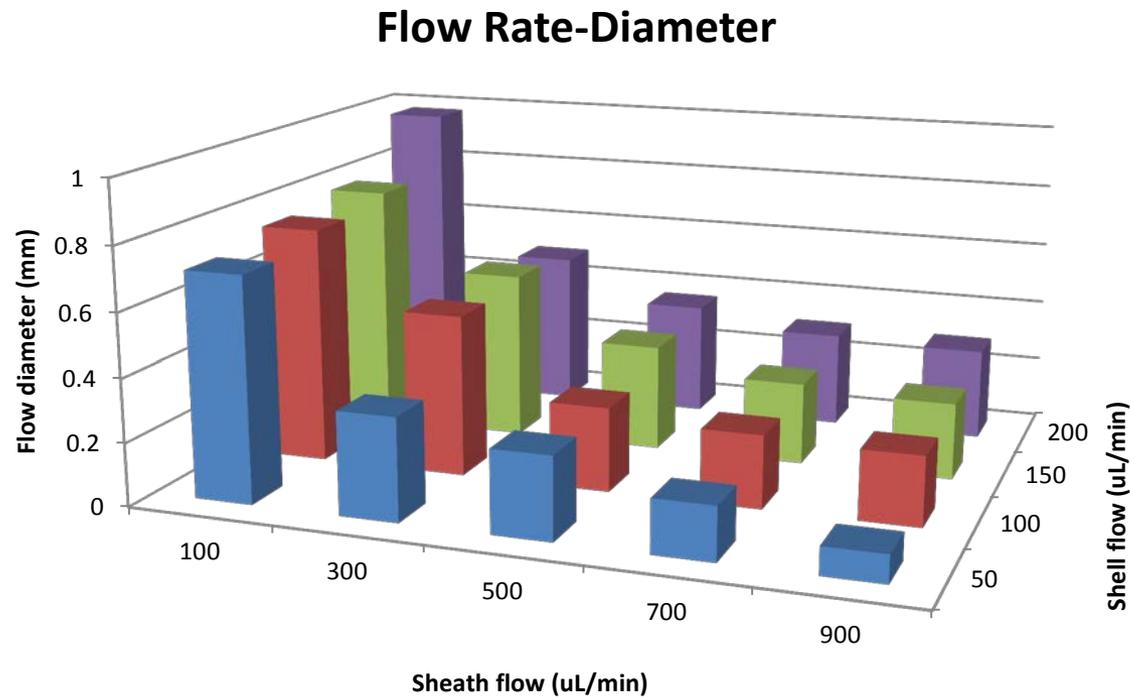


- Biocompatible: 2wt% sodium alginate



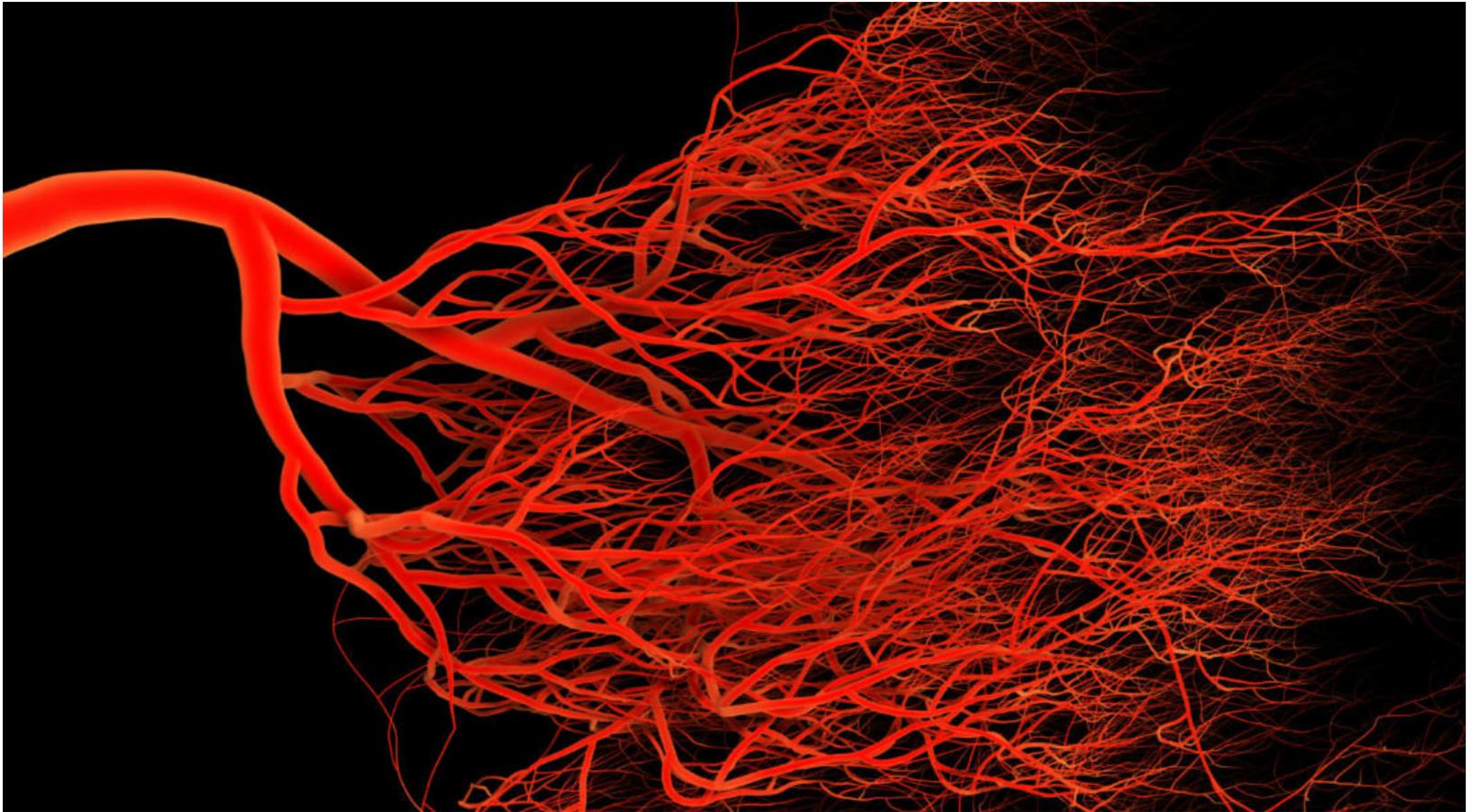
Flow-rate Dependent Fiber Diameter

- Sheath flow plays more significant role.



How to build a beating heart?

- from microvessels...



<https://singularityhub.com>