

1222-2022
800
ANNI



UNIVERSITÀ
DEGLI STUDI
DI PADOVA



Fondazione
ISTITUTO DI RICERCA
PEDIATRICA

Lo sviluppo della medicina del futuro: l'importanza dell'Ingegneria per una ricerca multidisciplinare ed innovativa

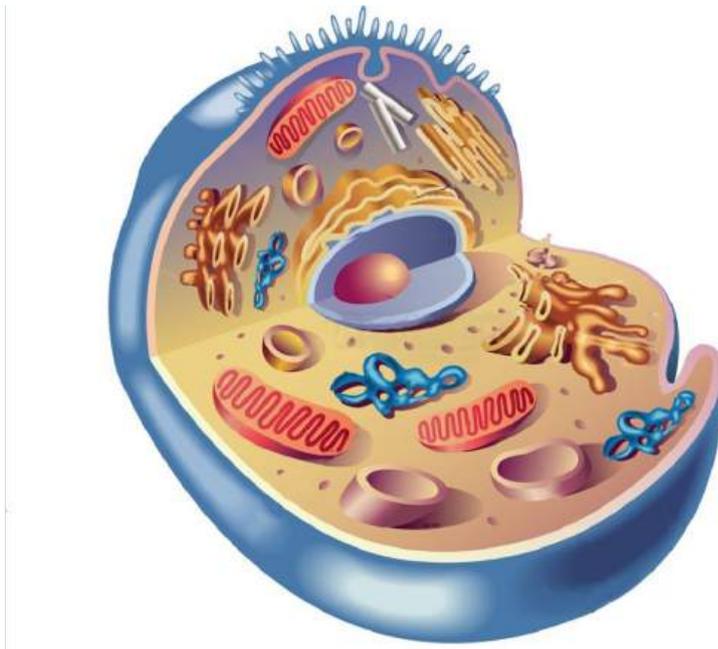


Collegio Ingegneri Venezia, 05 Aprile 2025

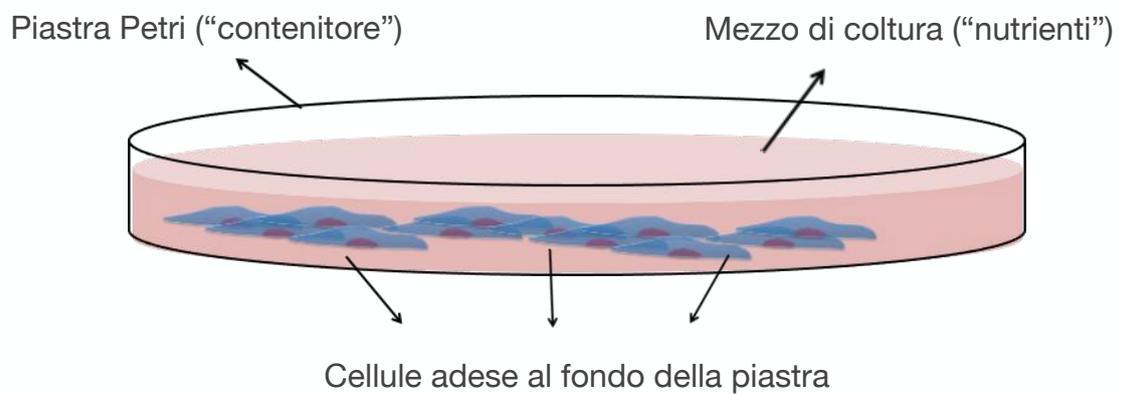
Elisa Cimetta



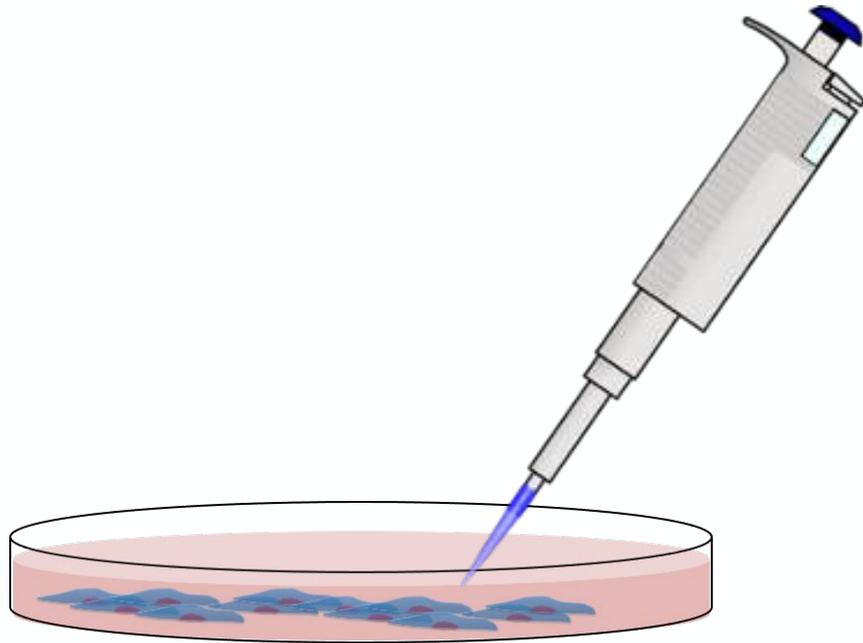




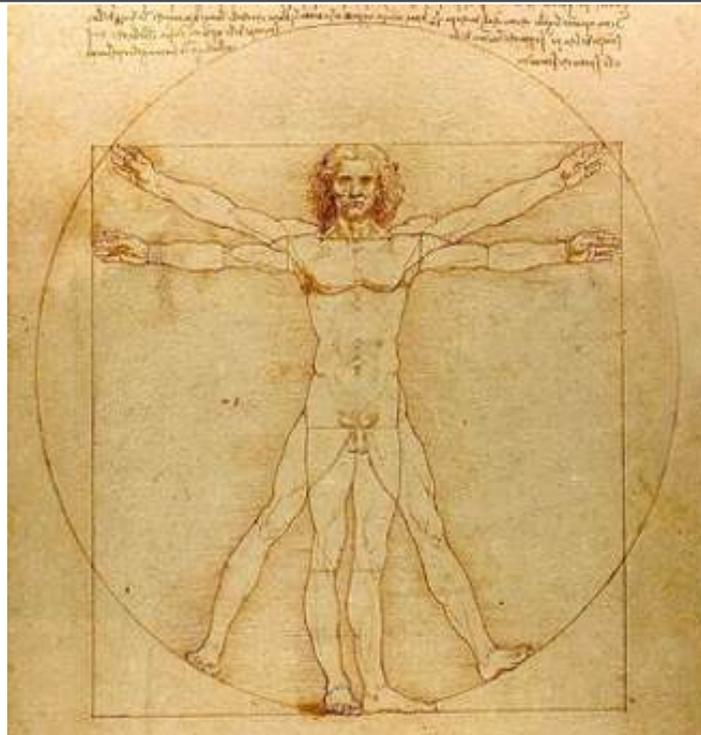
Colture cellulari: metodi standard

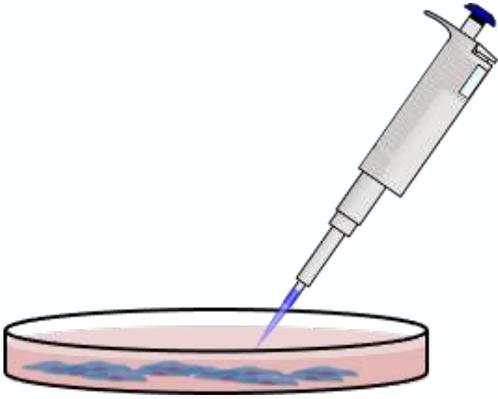


Colture cellulari: metodi standard

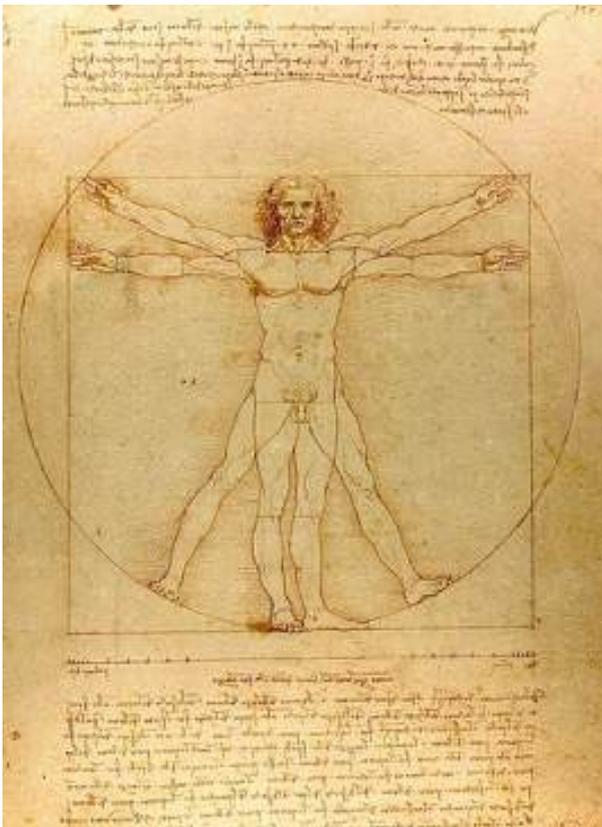
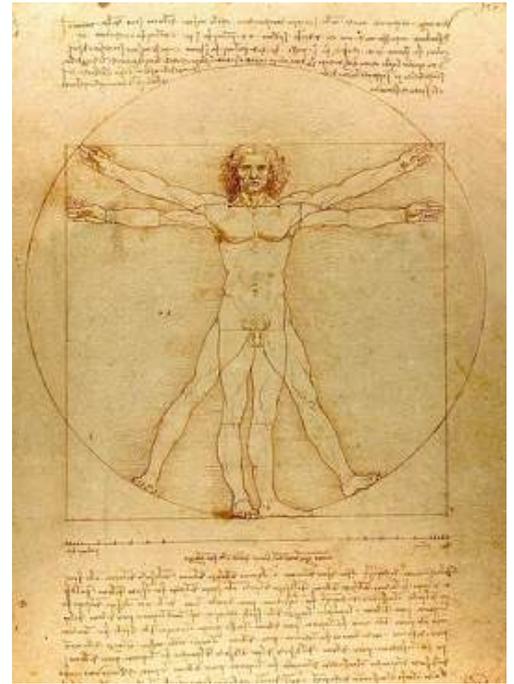


Ma il nostro corpo...



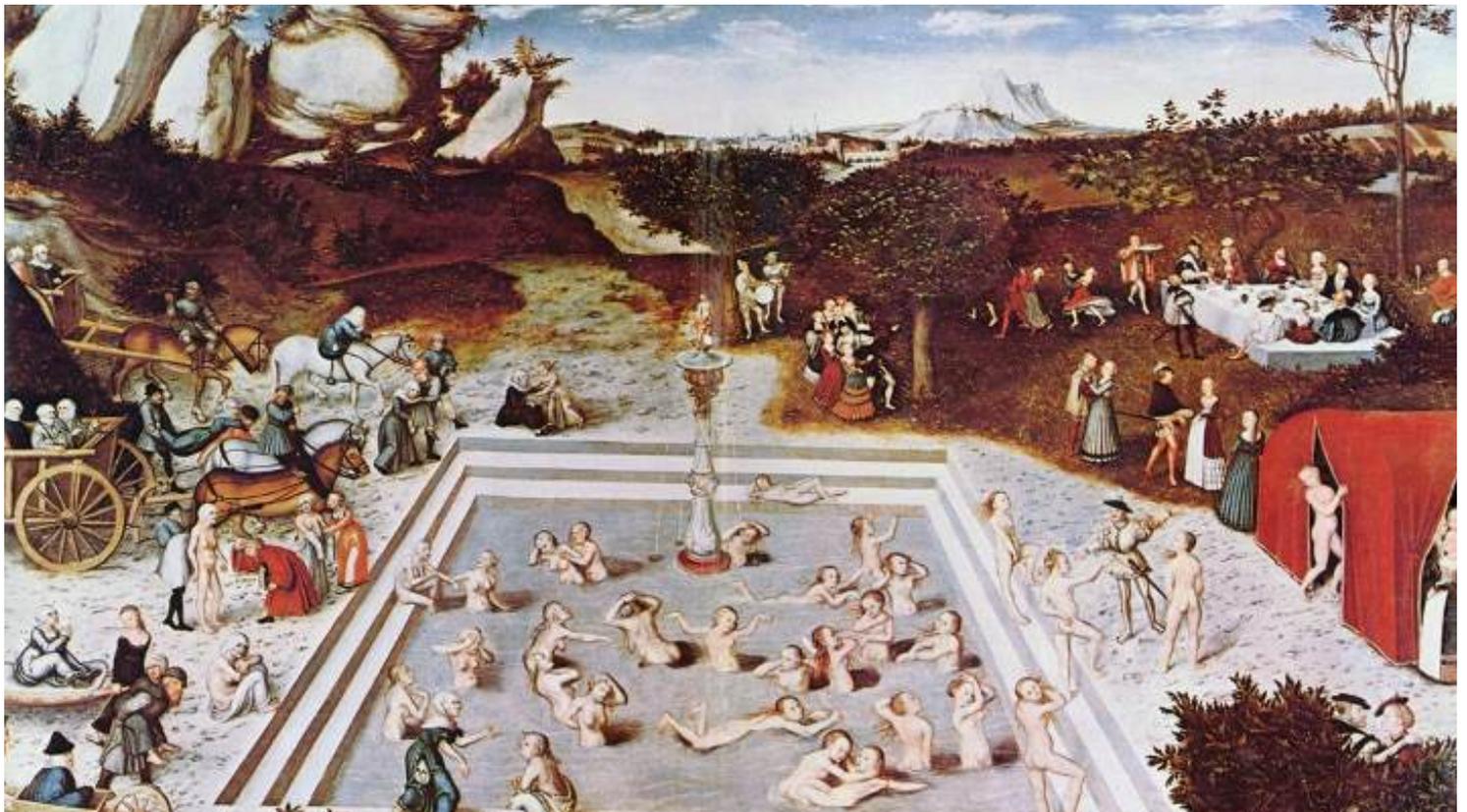


?



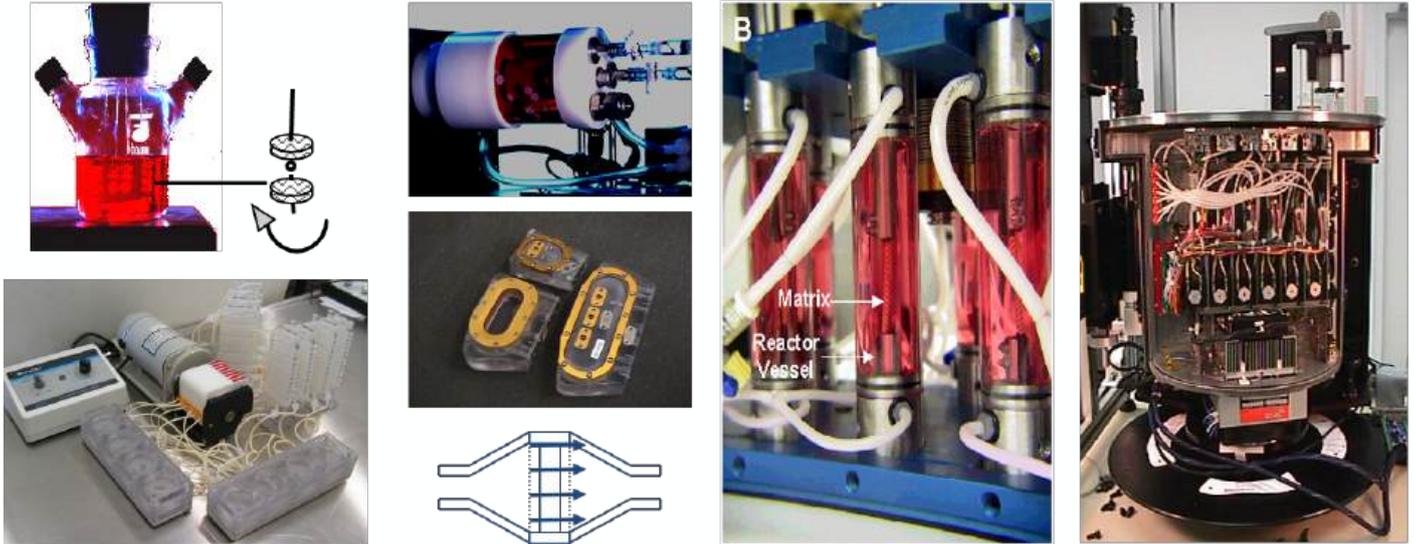
*“Lo ingegno umano
non troverà mai
invenzione più bella,
né più facile, né più
brieve della natura,
ove nulla manca e
nulla è superfluo”.*


**KEEP
CALM
AND TRUST
THE
ENGINEER**



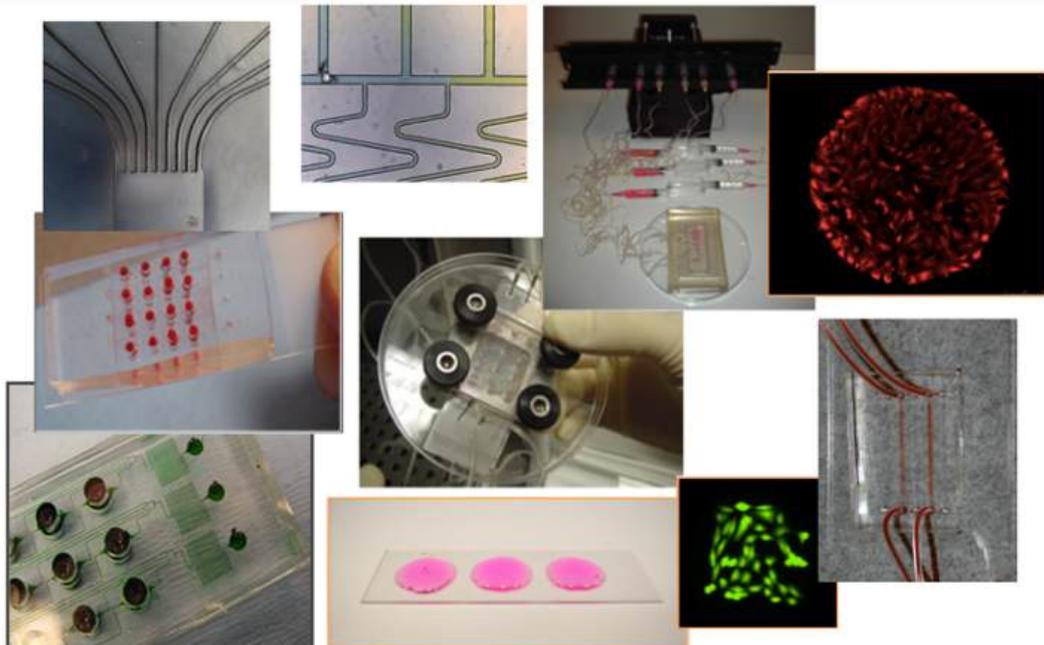
Ingegnerizzazione della Biologia

Soluzione tecnologica: **Bioreattori**

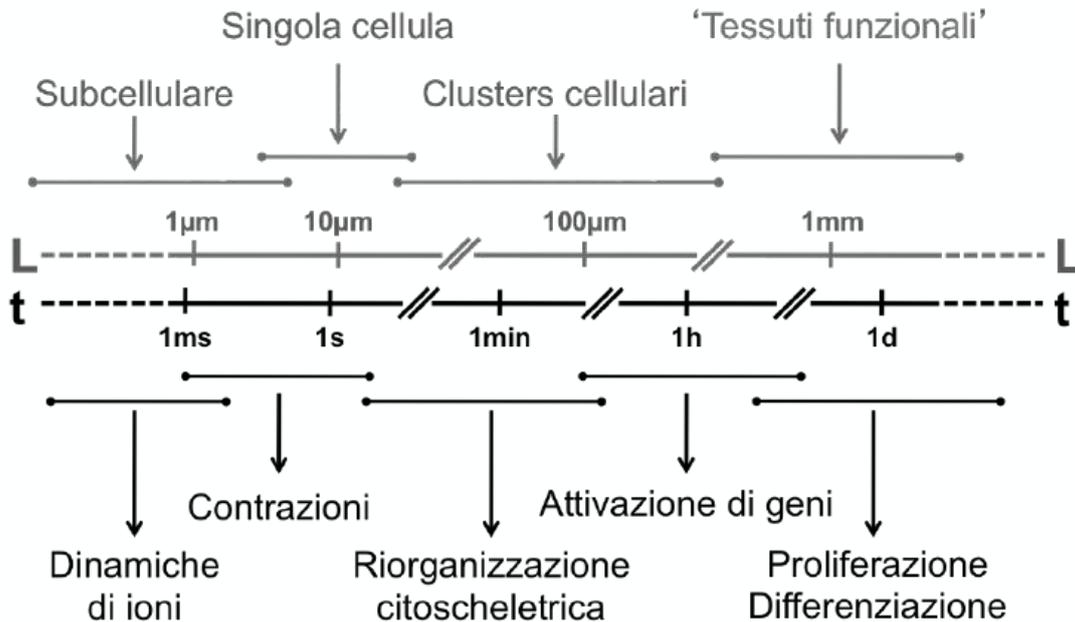


Scala: Macro \rightarrow Micro

Soluzione tecnologica: **Microbioreattori**



Un problema multiscala



..Fenomeni di Trasporto

- + nutrienti e ossigeno
- - prodotti di scarto
- Controllo delle concentrazioni all'interno di cellule e tessuti
- **Diffusione**: movimento molecolare guidato da gradiente di concentrazione
- **Convezione**: movimento "bulk" guidato da gradiente di pressione
- **Trasporto Attivo**: movimento "contro gradiente", richiede energia

..Fenomeni di Trasporto

Importanza dei fattori di scala

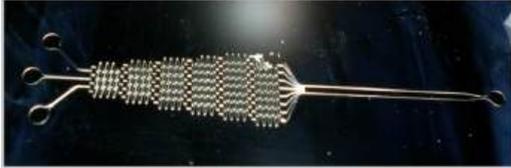
Distance	Diffusion time	Example from the living world
10 nm	100 ns	cell membrane
1 μm	1 ms	mitochondrion
10 μm	100 ms	small mammalian cell
100 μm	10 s	large muscle fiber
1 mm	1 min	half-thickness of a muscle
2 mm	1.1 hr	half-thickness of the eye lens
2 cm	4.6 days	thickness of ventricle
1 m	31.7 years	length of a nerve or muscle

Perche' Microbioreattori?

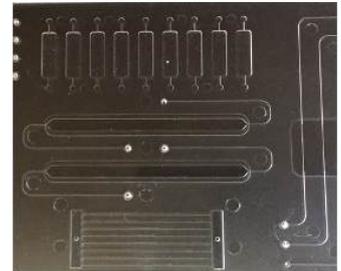
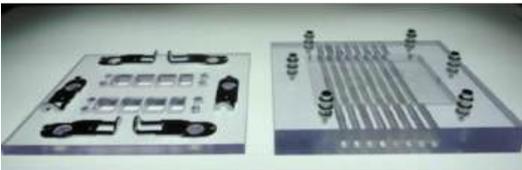
- Ci avviciniamo alle dimensioni caratteristiche di cellule e tessuti
- Miglior controllo e regolazione dei parametri sperimentali
- Possibilita' di mimare in vitro gli stimoli che le cellule sentono nel nostro corpo
- Semplificazione dei modelli matematici

Microbioreattori: fabbricazione

- Fotolitografia



- Stampa 3D -
Additive Manufacturing

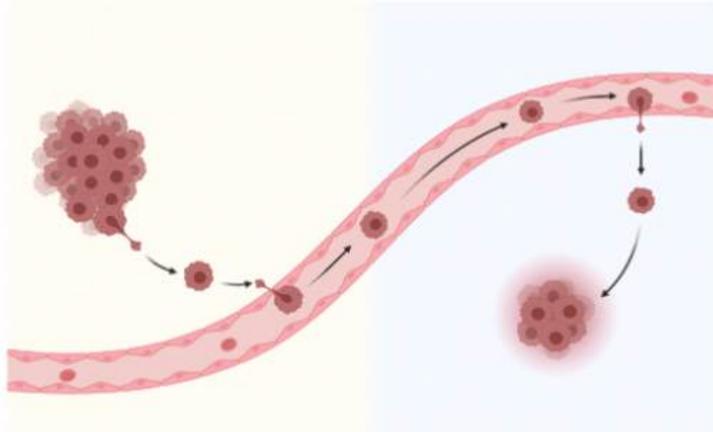


Caso Studio: Neuroblastoma e Metastasi

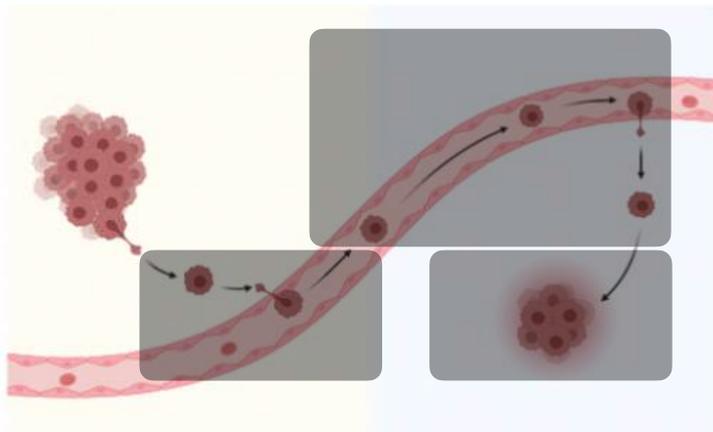
Incognite:

- Come comunicano le cellule del tumore con il loro microambiente?
- Concentrazioni diverse generano risposte diverse?
- Come parte il processo metastatico?
- Come si muovono le cellule tumorali? Cosa le “spinge”?
- Come fanno a evadere dal tumore primario e raggiungere il sito metastatico?
- ...

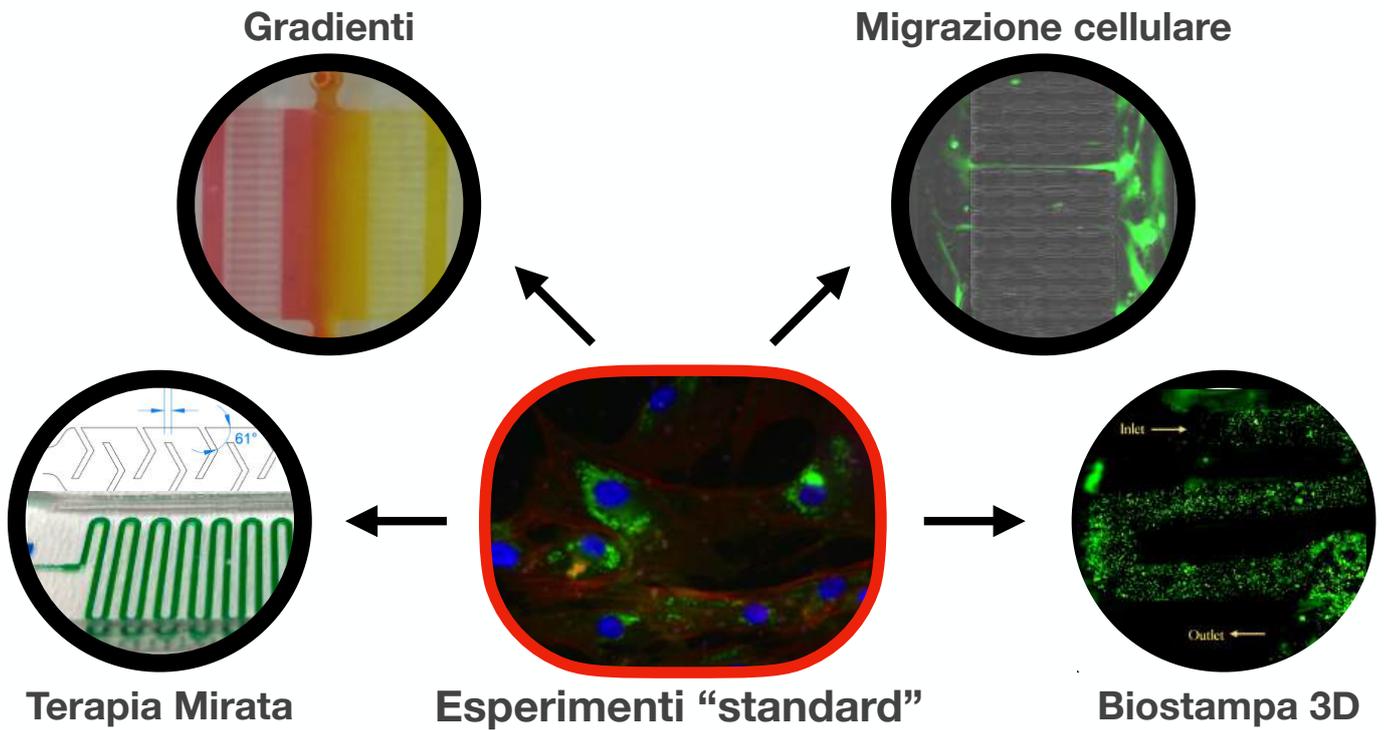
Schematizziamo il problema



Schematizziamo il problema

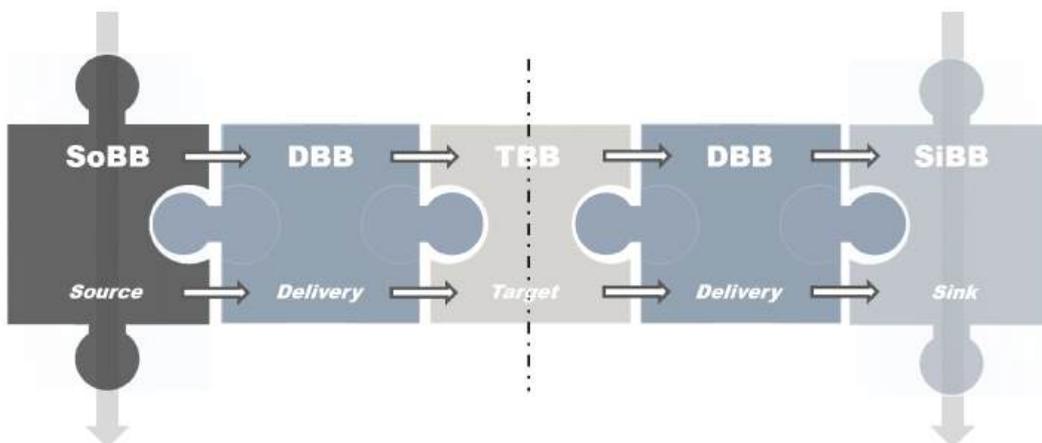


Rispondiamo alle domande..

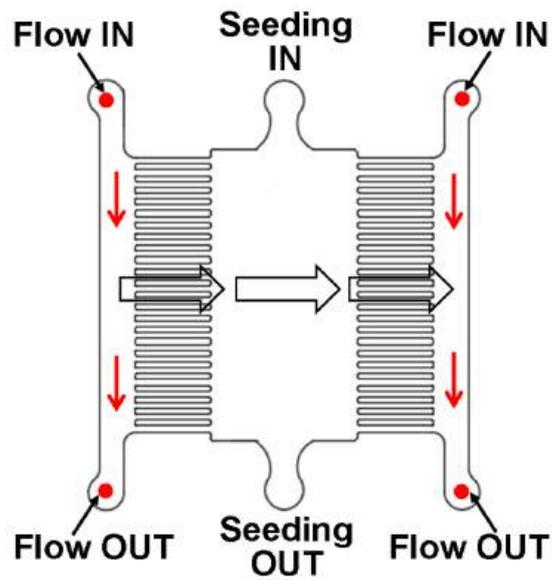


μ BR: generatore di gradienti

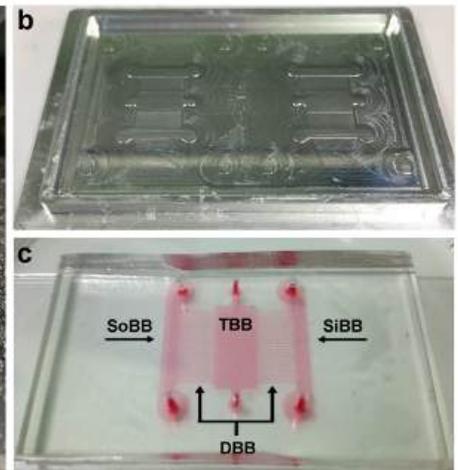
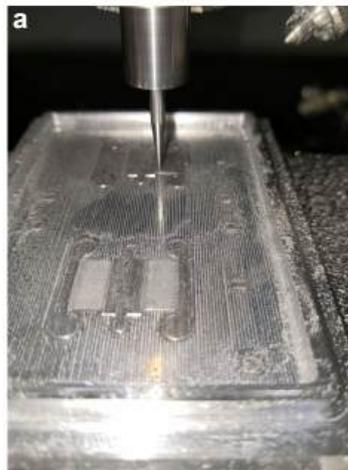
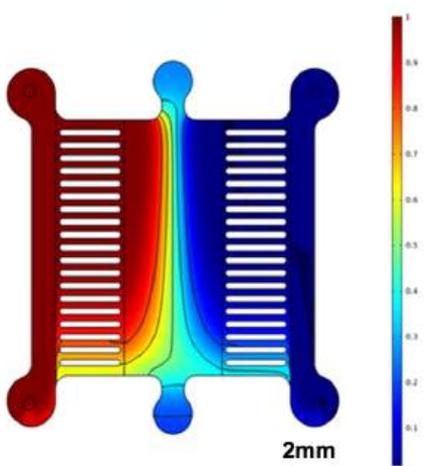
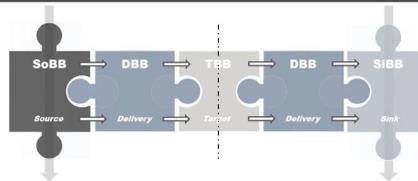
Descrizione dei componenti: "Building Blocks" (BB)



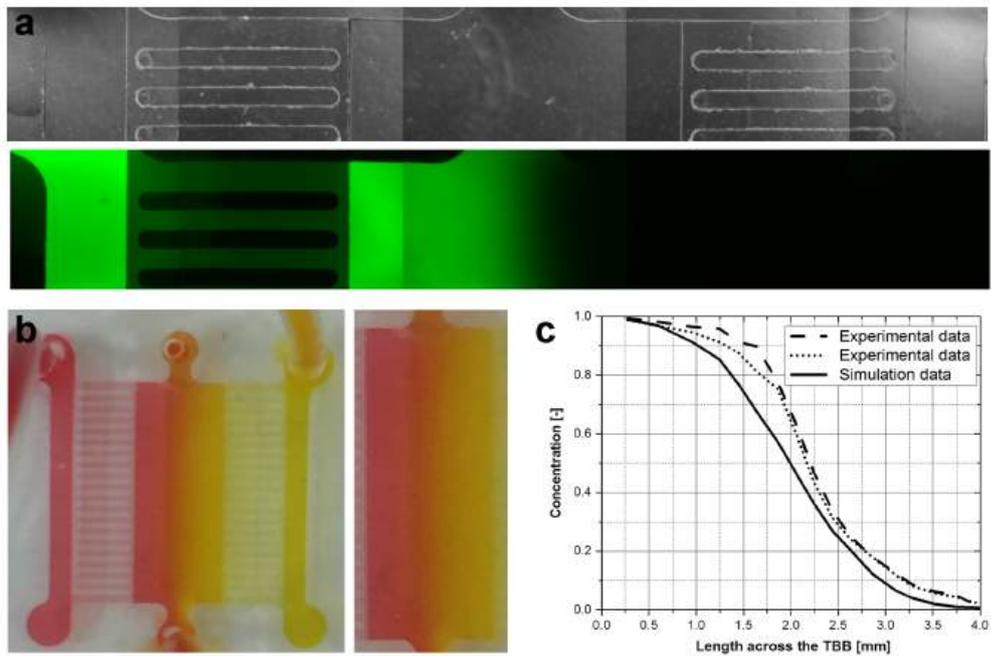
μ BR: generatore di gradienti



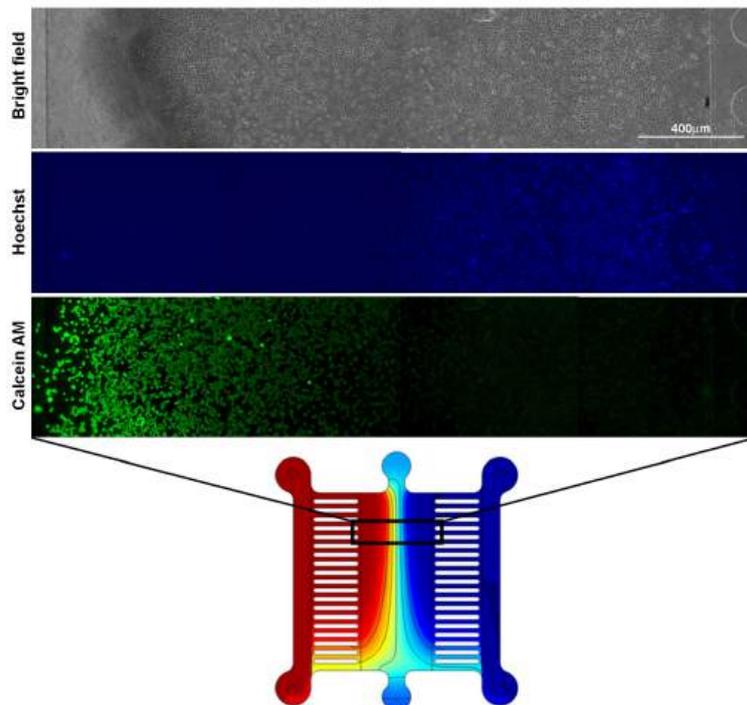
μ BR: generatore di gradienti



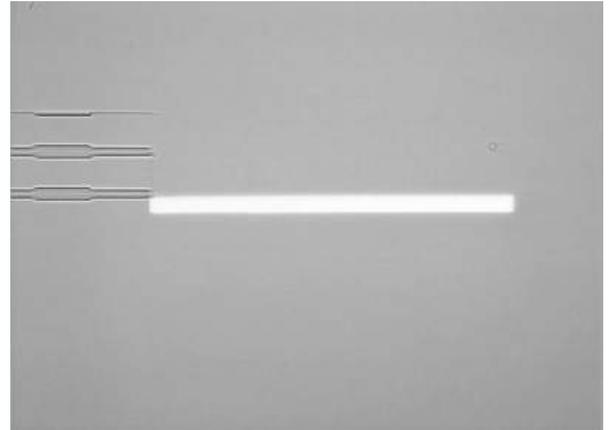
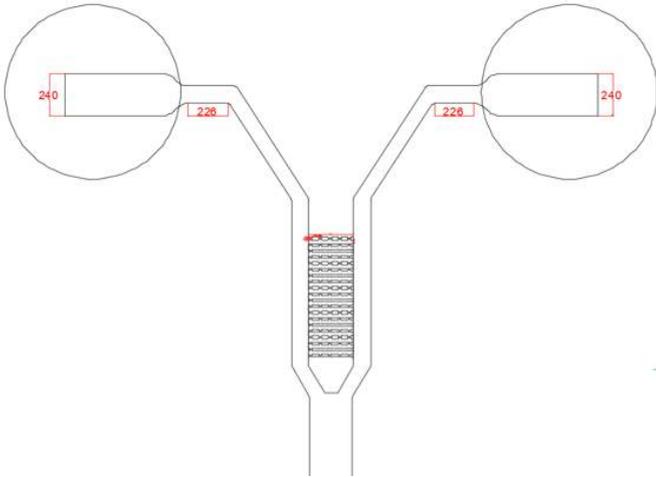
μ BR: generatore di gradienti



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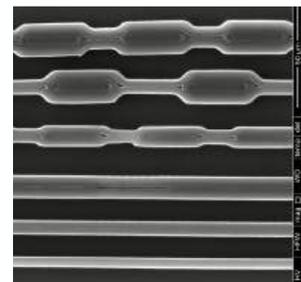
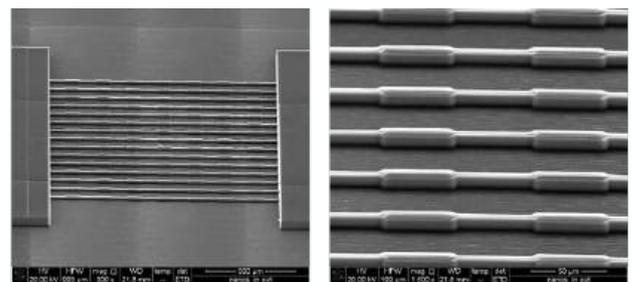
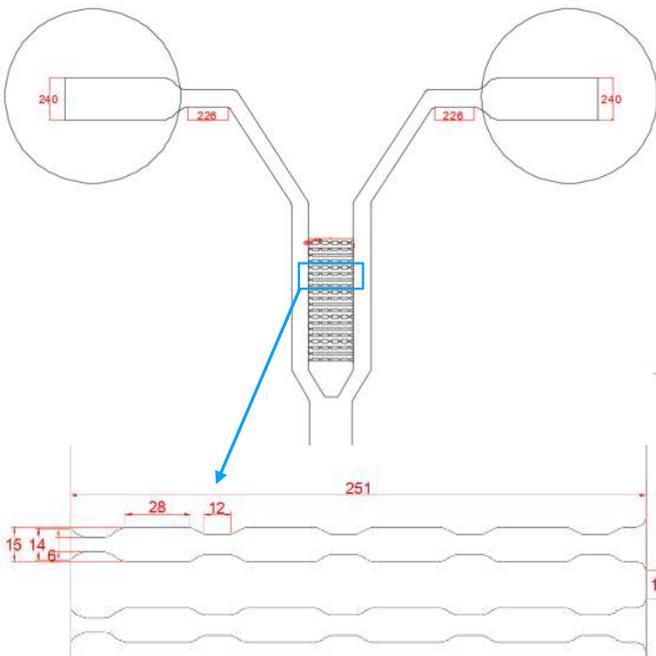


μ BR: studio della migrazione

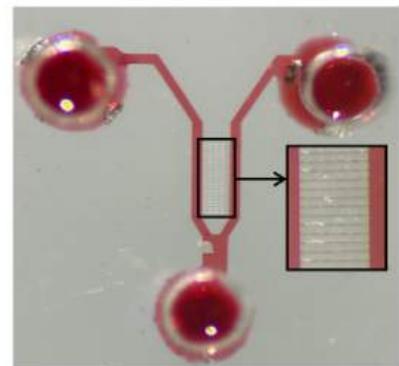
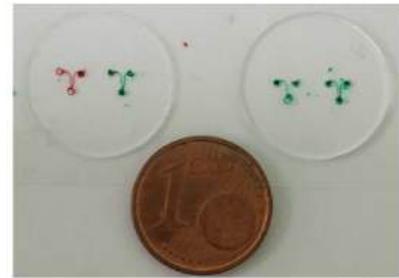
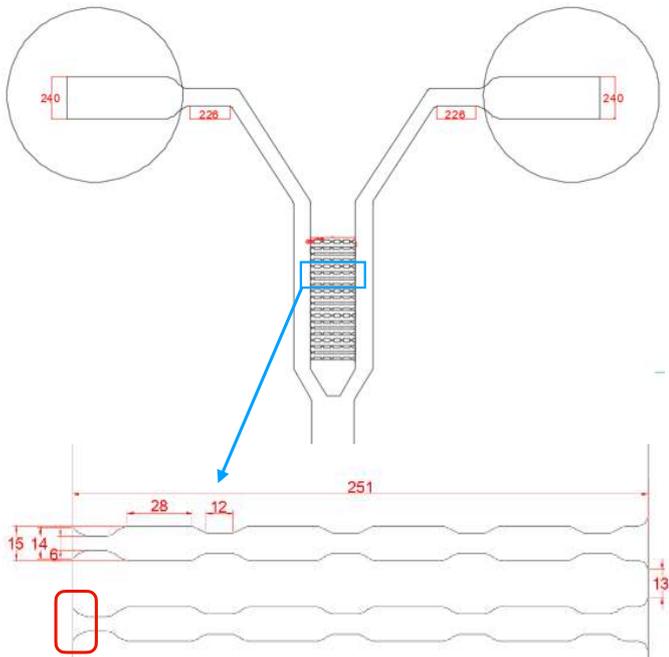


Polimerizzazione a due fotoni (2PP)

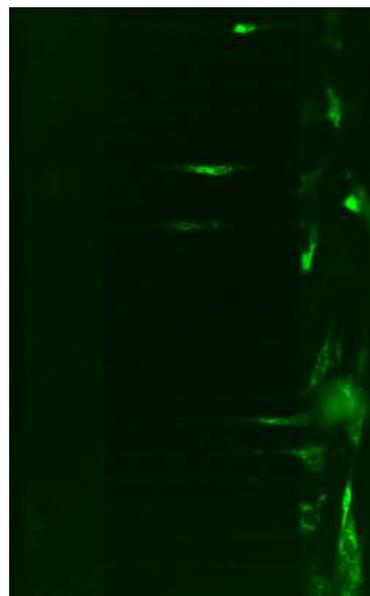
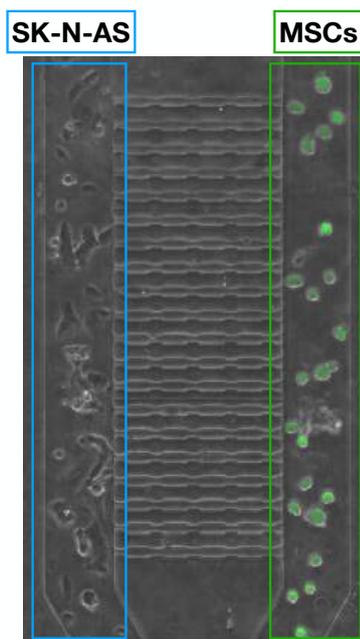
μ BR: studio della migrazione



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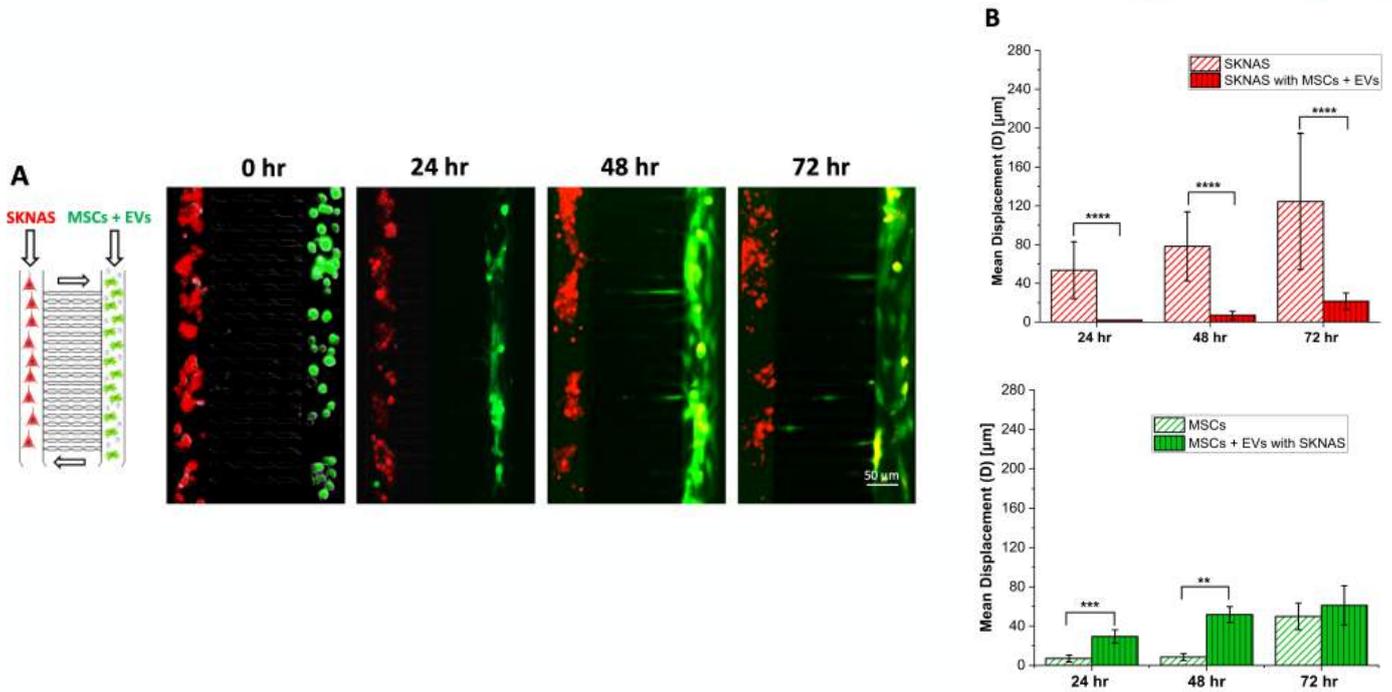


μ BR: studio della migrazione

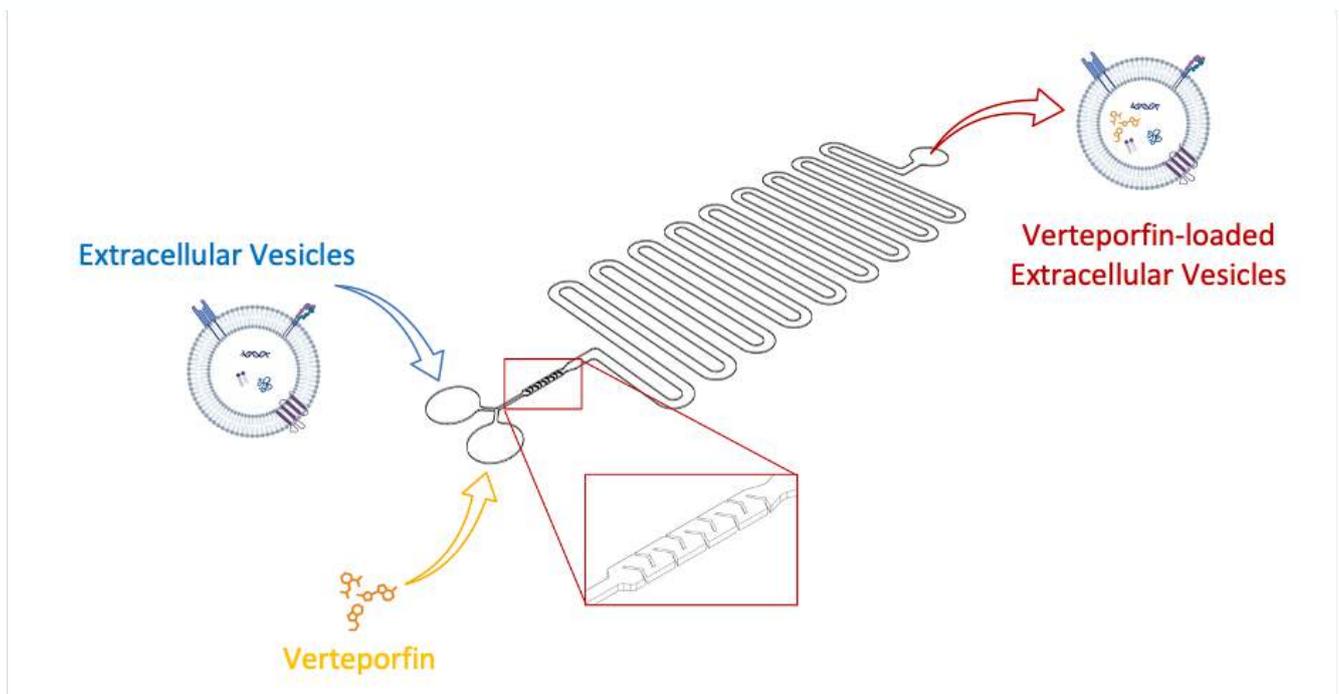


Tempo = 72h

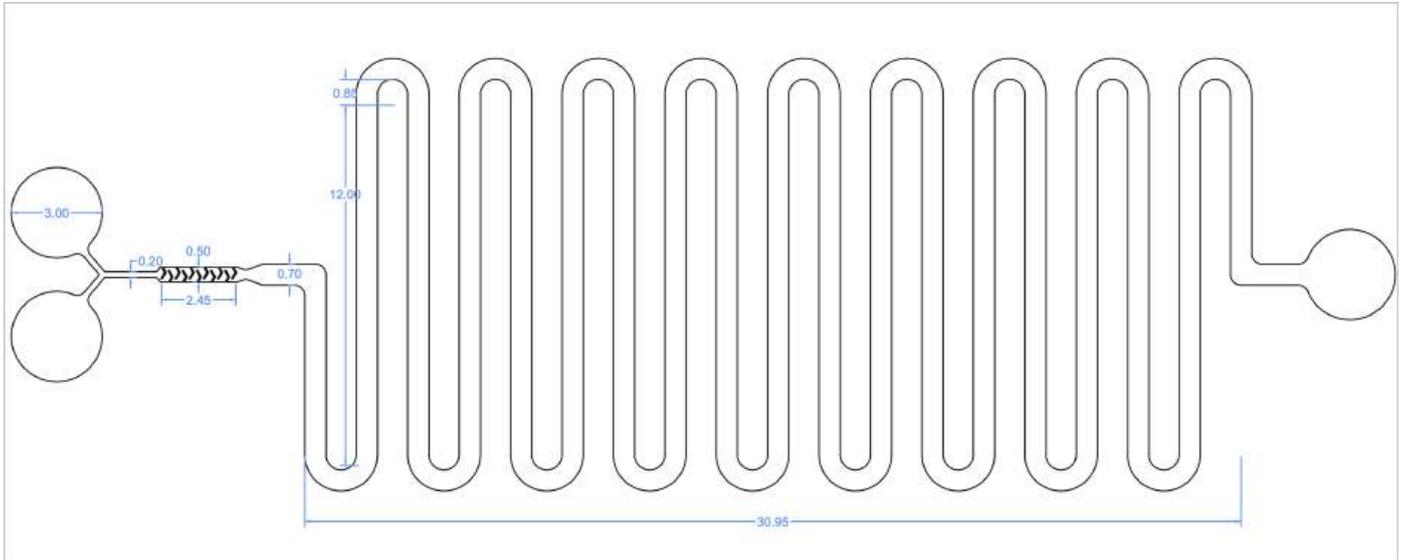
μBR: studio della migrazione



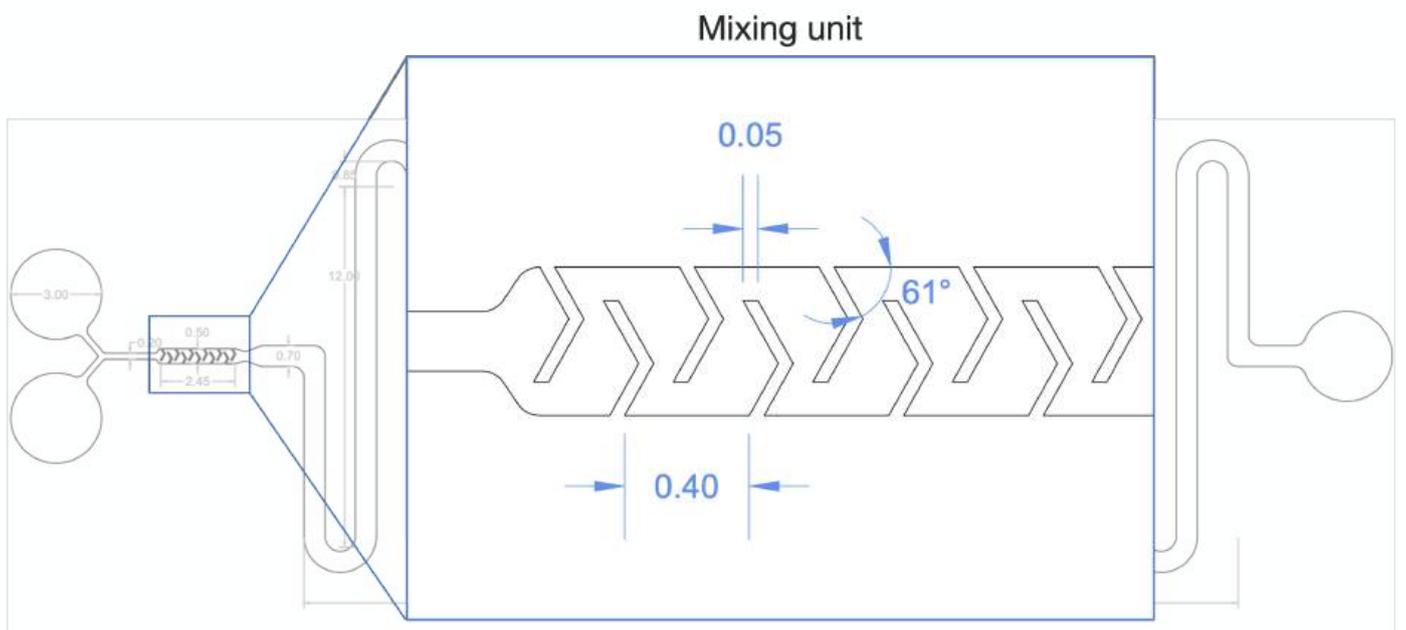
Terapia mirata: “Cavallo di Troia”



Terapia mirata: “Cavallo di Troia”

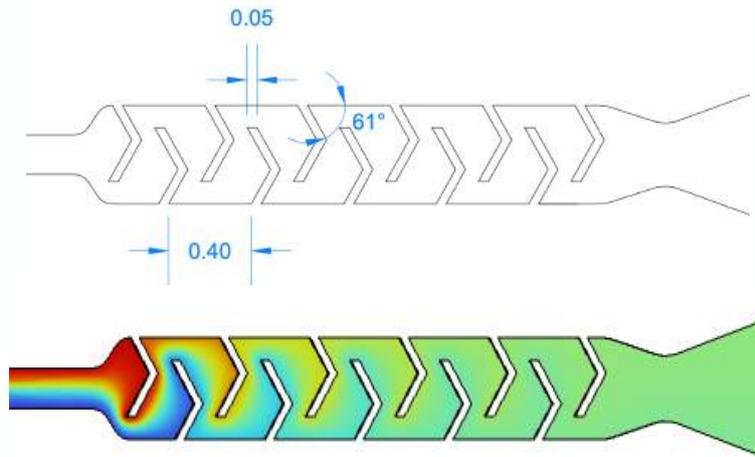


Terapia mirata: “Cavallo di Troia”



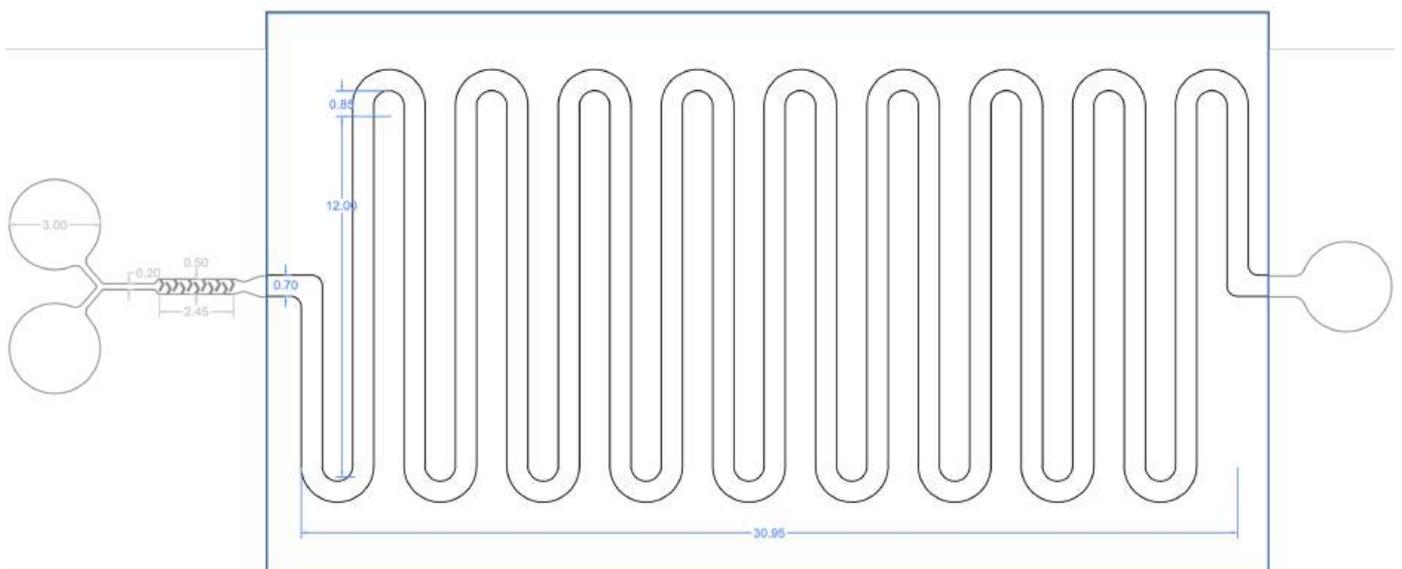
Terapia mirata: “Cavallo di Troia”

Micromixer

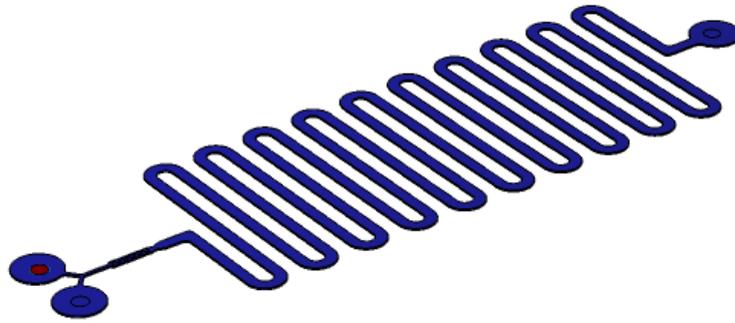


Terapia mirata: “Cavallo di Troia”

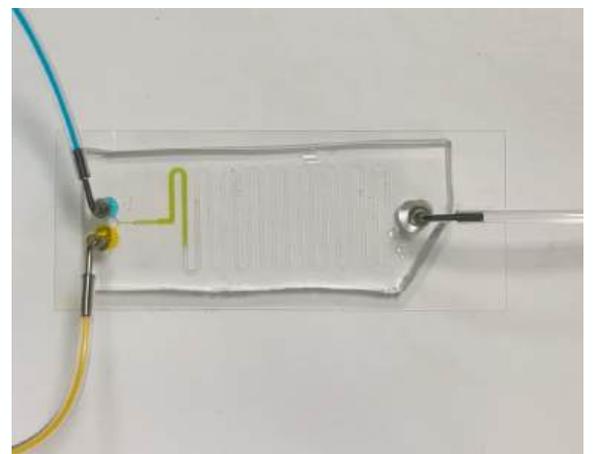
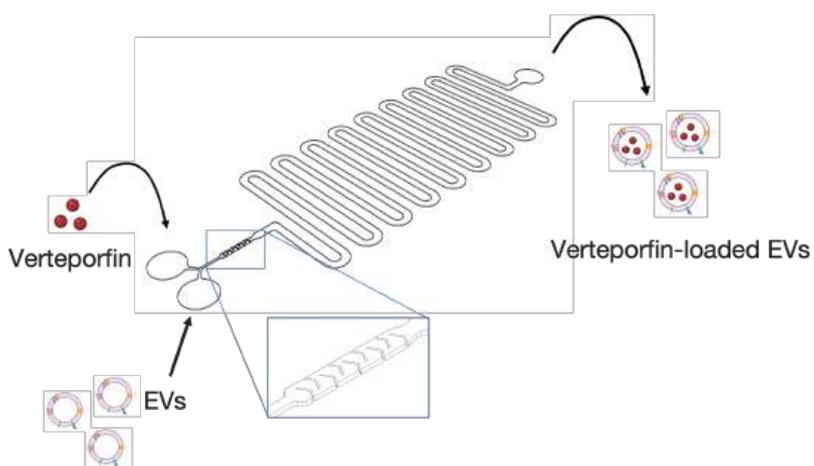
Incubation unit



Modellazione e validazione del dispositivo

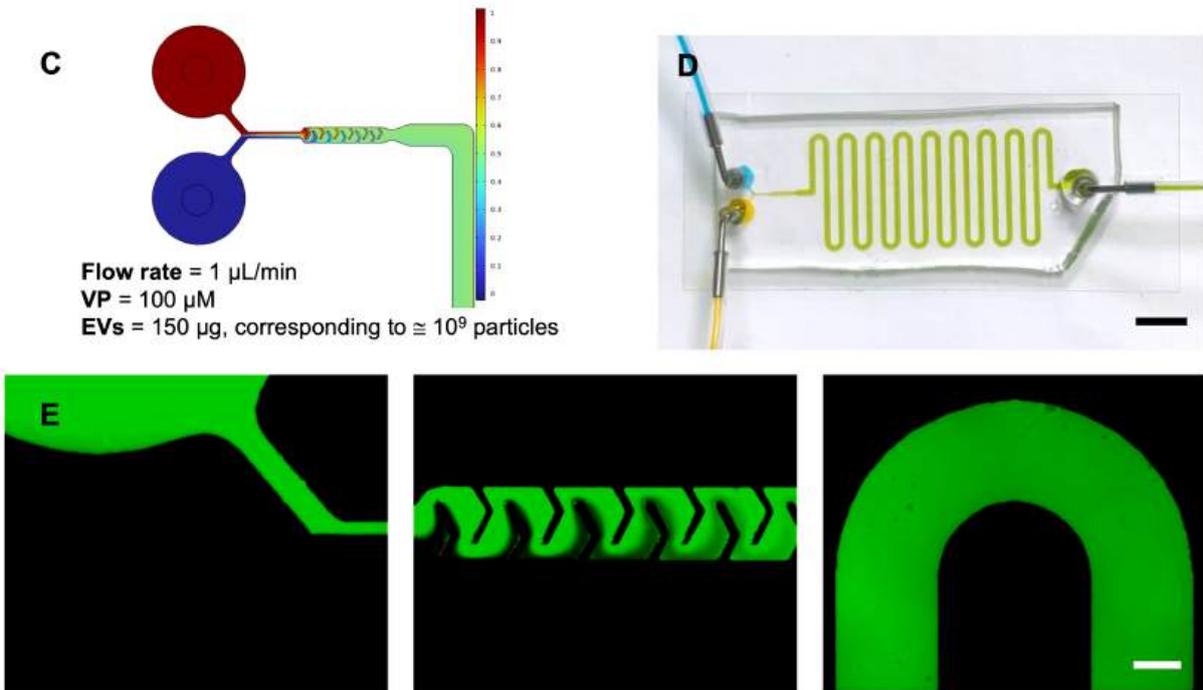


Modellazione e validazione del dispositivo

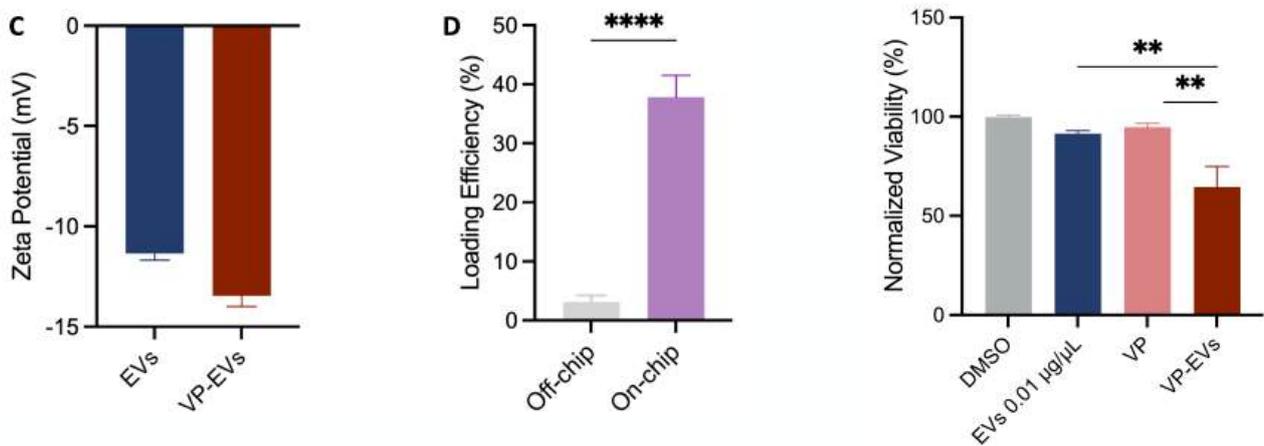


Incubation at room temperature for 10 mins

Modellazione e validazione del dispositivo

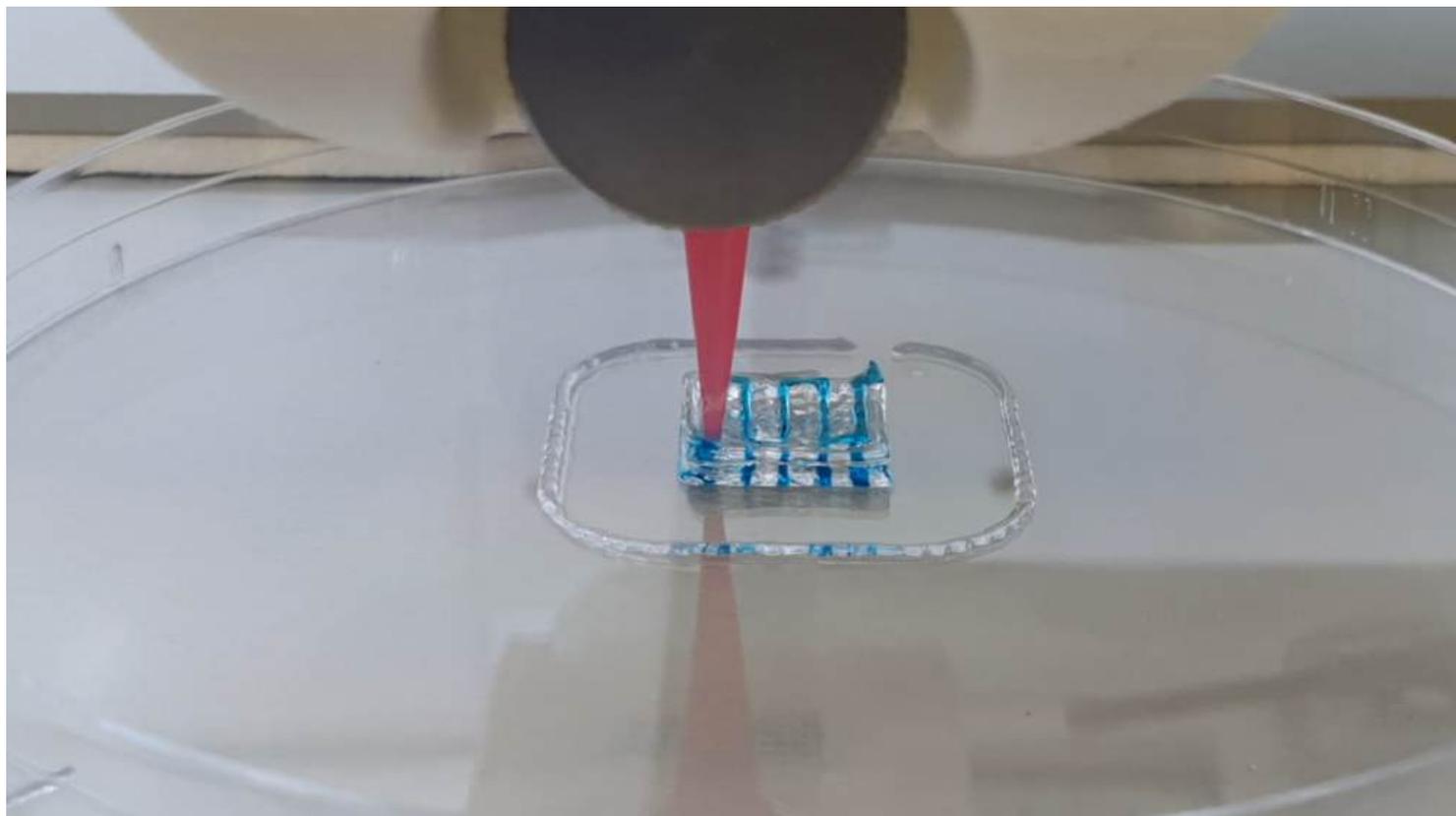


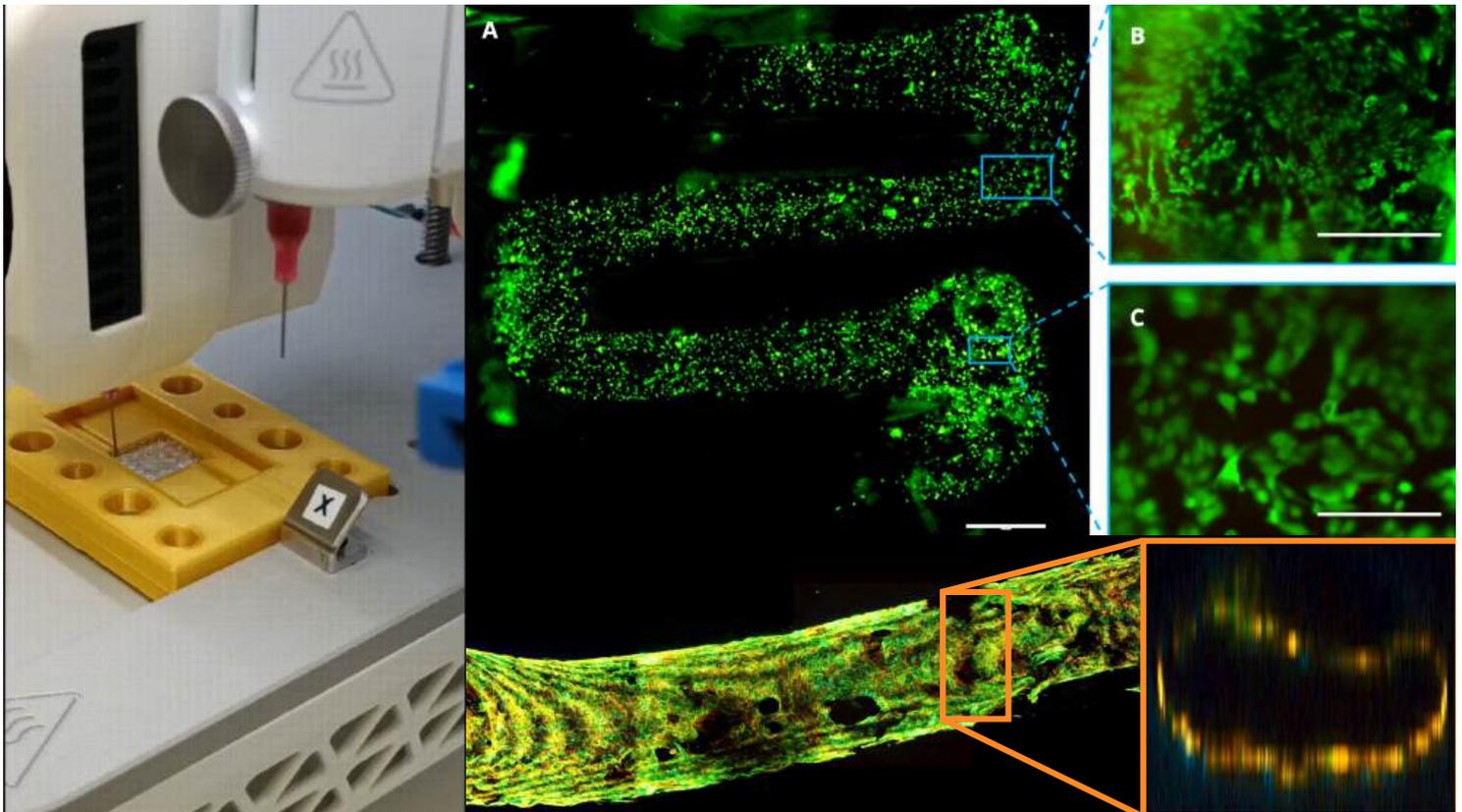
Modellazione e validazione del dispositivo



Biostampa 3D

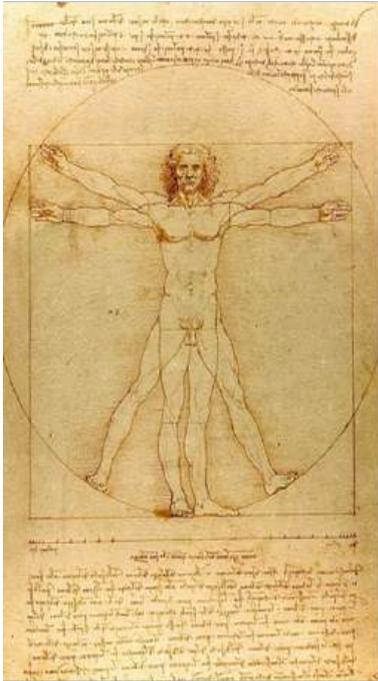
...verso lo sviluppo di modelli tridimensionali di tessuto vascolarizzato





.. e il futuro??

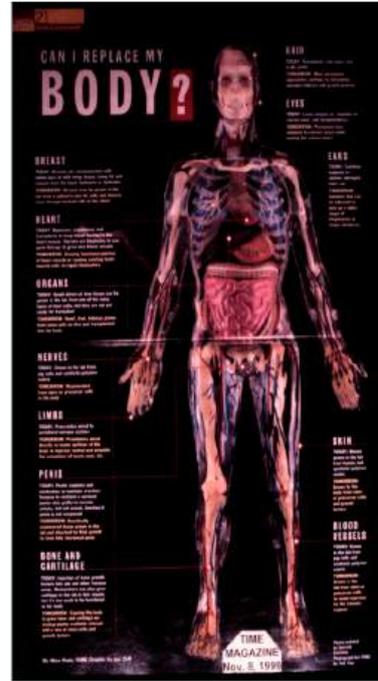
Body 1.0 [1490]



Body 2.0 [1989]



Body 3.0 [1999]



.. e il futuro??

Body 4.0 ??

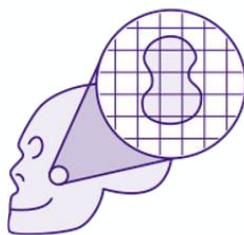
Fabbrichiamo tessuto osseo

Materie prime:

- Cellule + Impalcatura (scaffold)
+ Bioreattore

Ingredienti segreti:

- Le cellule sono quelle del paziente
- La forma dell'osso e' esattamente quella del paziente

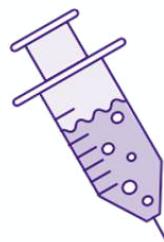
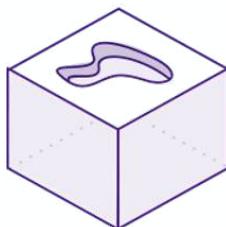


1. Scanning

CT scan / graph
paper / skull /
extracting shape

2. 3D Design

Use CT imaging to
create a personalized
bone scaffold

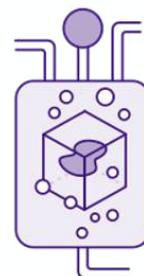


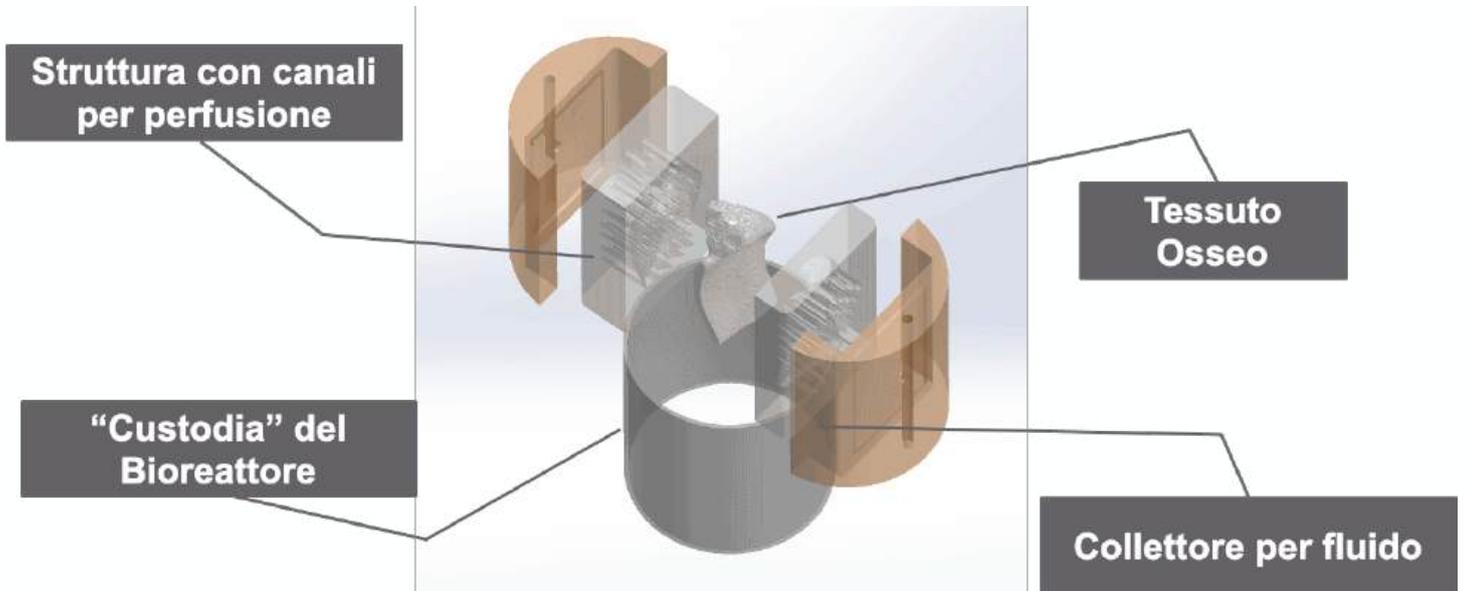
3. Patient Cells

Harvest patient stem
cells through
liposuction

4. Maturation

cells mature throughout
scaffold for 1-5 weeks in
bioreactor





**The future is being designed
one cell at a time.**



Per concludere...

- Per fare un buon prodotto servono ottime materie prime..
- ..e mani esperte per combinarle al meglio..

- Usando e dosando le competenze di Ingegneria, Chimica, Biologia possiamo avanzare la conoscenza del nostro corpo, e creare nuove tecnologie capaci di migliorare la nostra salute e prevenire malattie...



biamet

