UF Herbert Wertheim College of Engineering
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Biomaterials for Modeling Immune Mediation in Wound Healing

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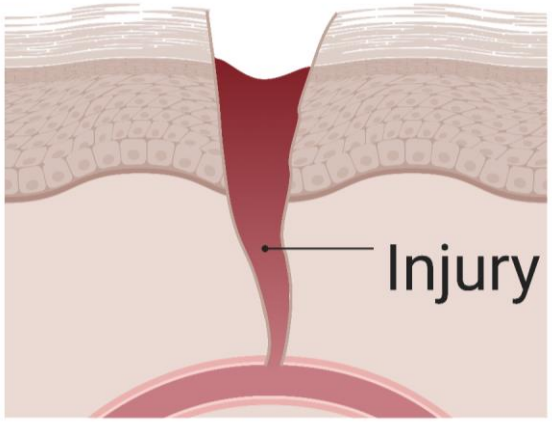
The National Academies of Sciences, Engineering and Medicine
11/2/21

Why is their variability in wound healing?

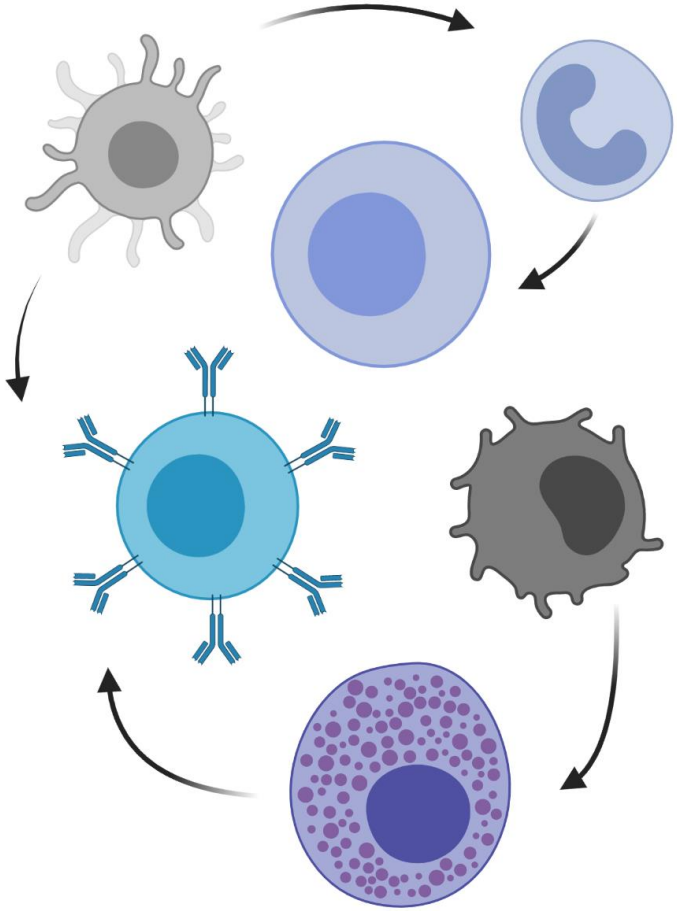


Open research questions

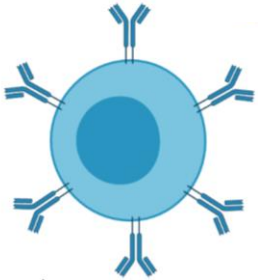
- Can we understand why there is variability in wound healing?

Immune cells: A coordinated team

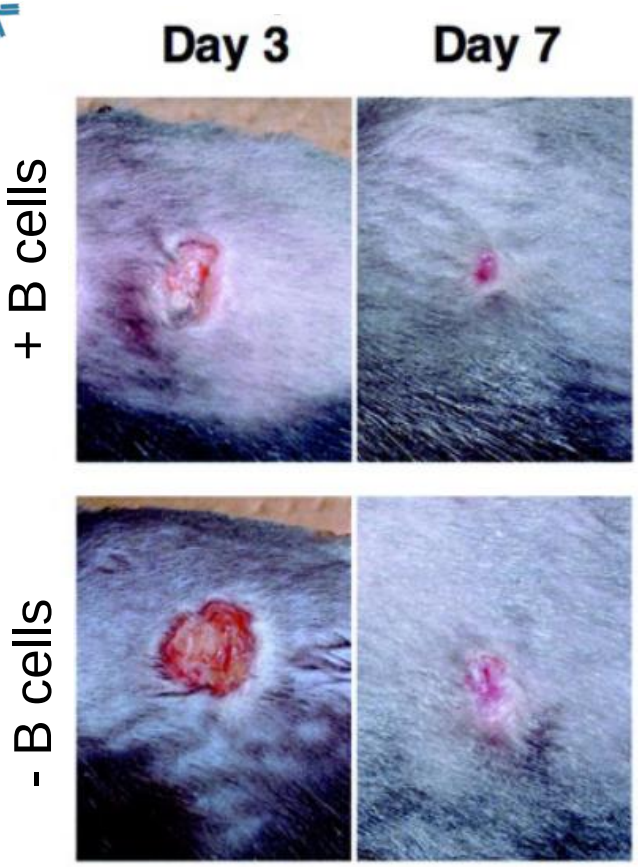
- Multiple immune cells comprise the immune response to injury
- Orchestrate wound healing through cell-cell communications



Immune cells orchestrate healing



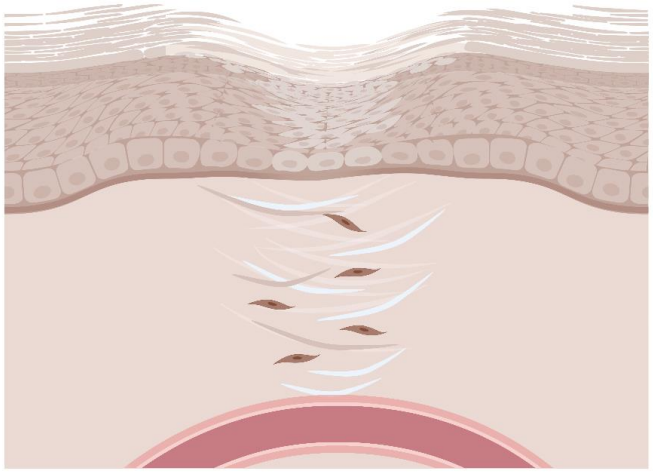
- B cells represent systemic response to injury
  - B cells are involved in wound healing
  - B cell dysregulation is associated with many diseases
- **How do B cells respond during wound healing?**



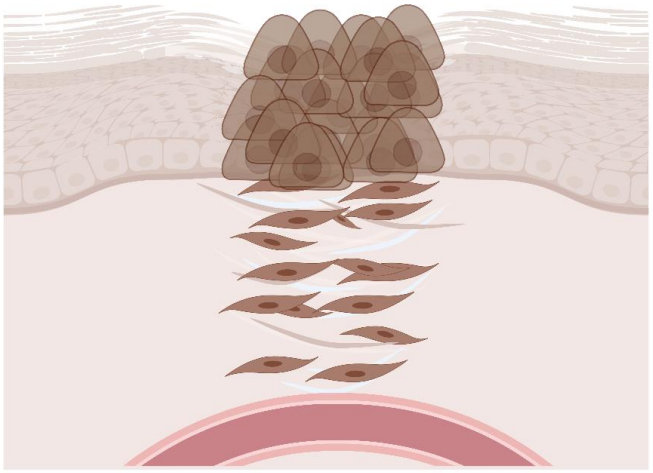
Iwata, Yohei, et al. *The American journal of pathology,* 2009.

Biomaterials to mimic wound healing differences

Pro-healing

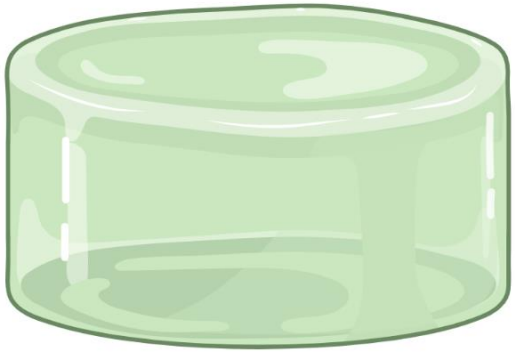


Pro-fibrotic

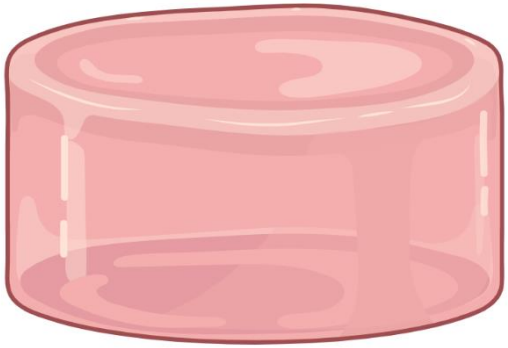


Biomaterials to mimic wound healing differences

Pro-healing materials

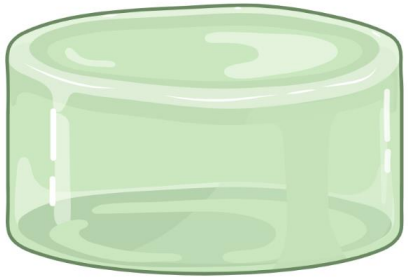


Pro-fibrotic materials

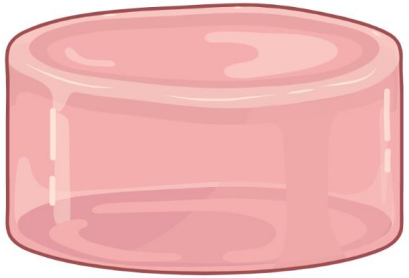


Biomaterials to manipulate wound healing

Pro-healing materials



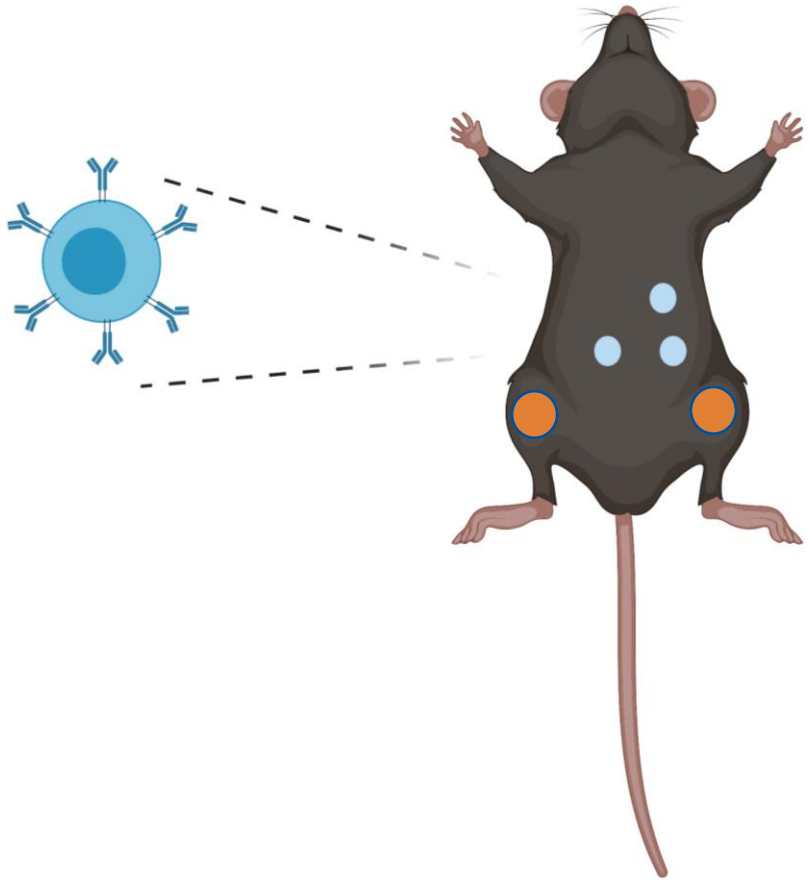
Pro-fibrotic materials



- Inform the local environment to skew wound healing
  - Pro-healing: Biomaterials that promote healing
  - Pro-fibrotic: Biomaterials that promote scarring and fibrosis

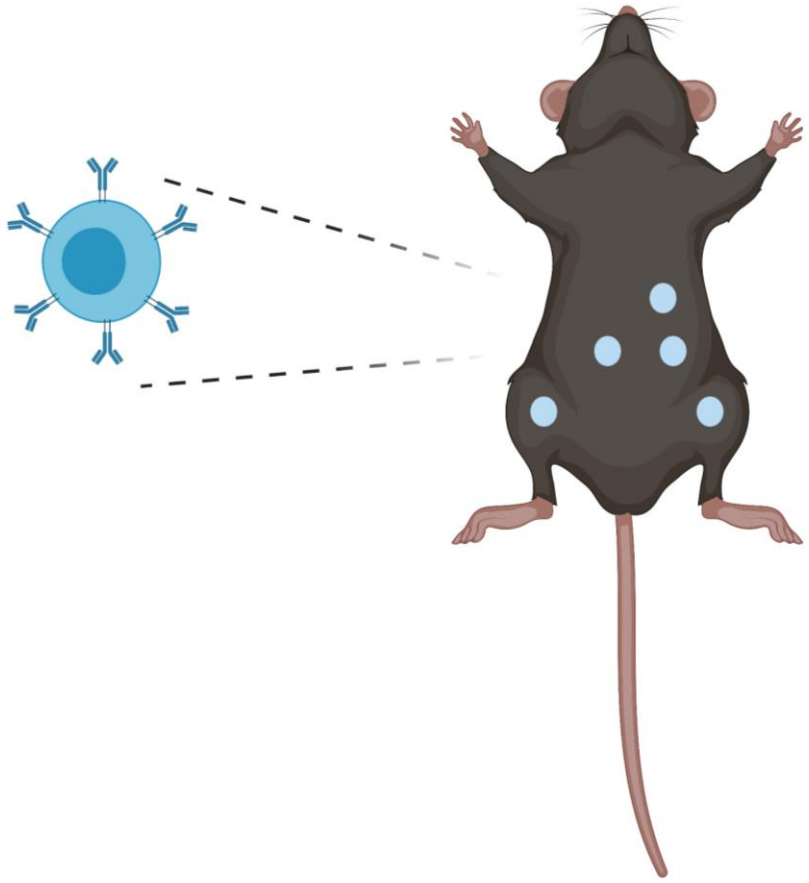
Alterations to the local environment influence systemic responses

- **Create muscle injury**
- **Implant biomaterial in muscle**
- Subsequent interrogation



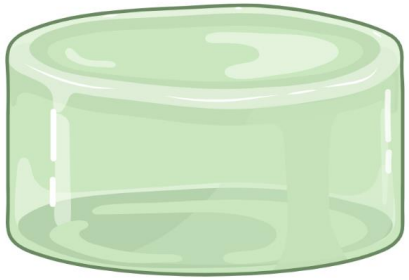
Alterations to the local environment influence systemic responses

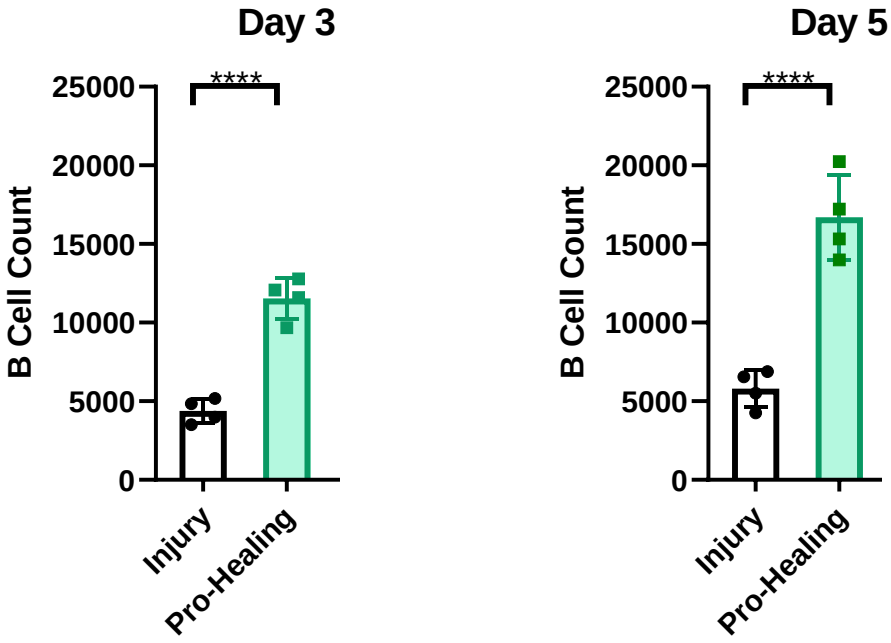
- Create muscle injury
- Implant biomaterial in muscle
- Subsequent interrogation
  - Local environment
  - Responses in different tissues



Biomaterials to manipulate wound healing

Pro-healing materials



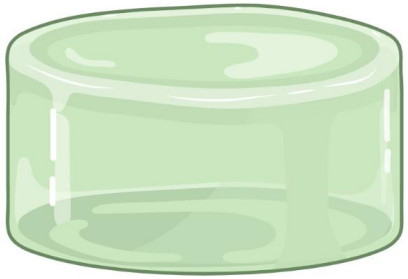


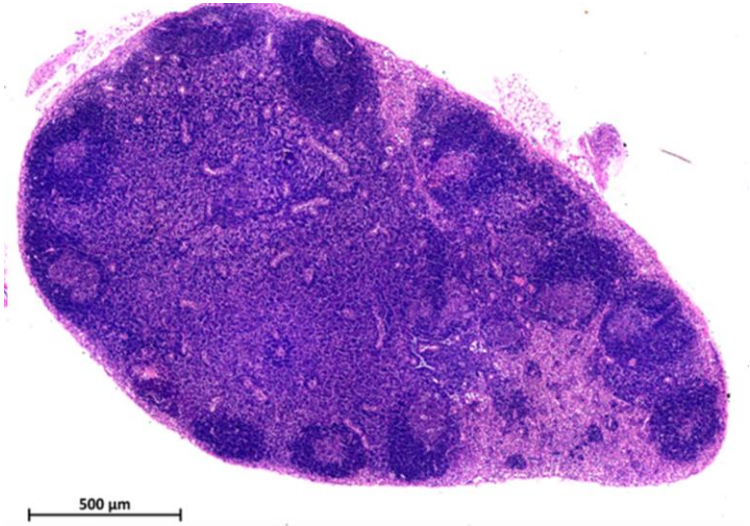
Post muscle injury with pro-healing biomaterial

- Pro-healing biomaterials recruit immature B cells early to the wound site

Biomaterials to manipulate wound healing

Pro-healing materials



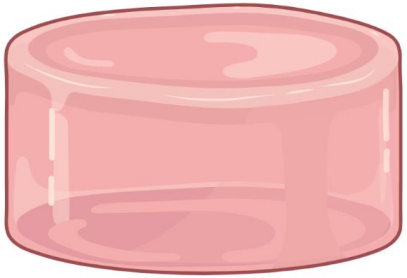


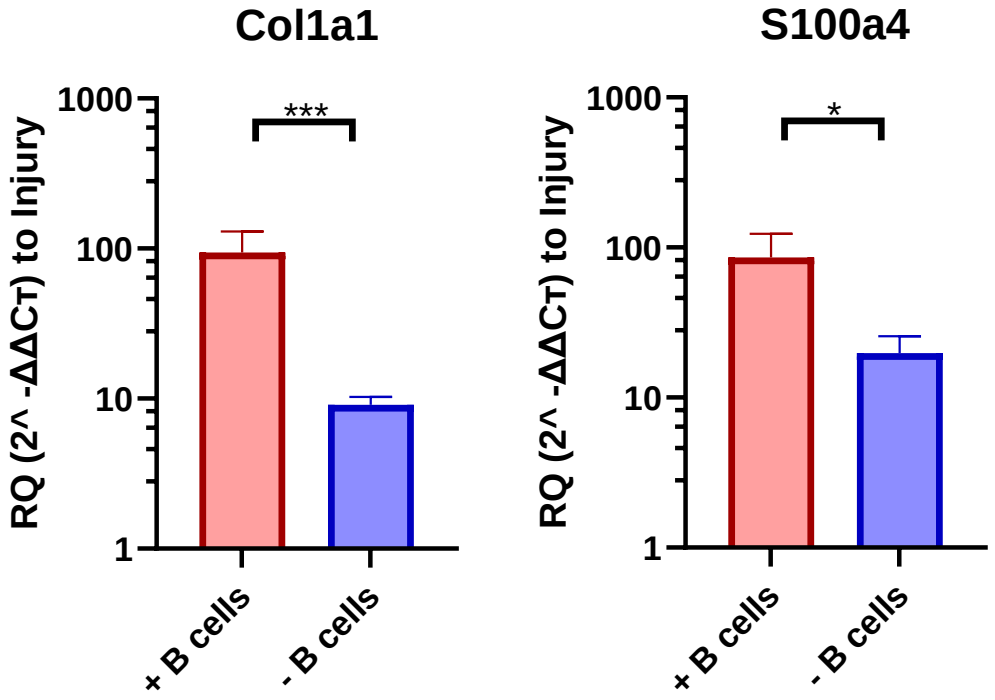
1 week post muscle injury with pro-healing biomaterial

- Pro-healing biomaterials inform tissue responses in the local the lymph node

Biomaterials to manipulate wound healing

Pro-fibrotic materials



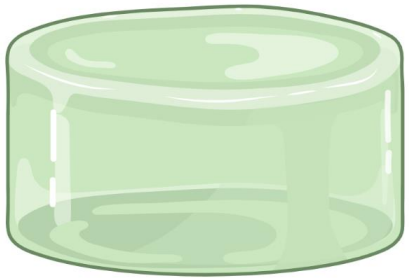


- Pro-fibrotic biomaterials recruit **Mature** B cells
- Removing mature B cells reduced fibrosis or scar formation

B cells in wound healing

Pro-healing materials

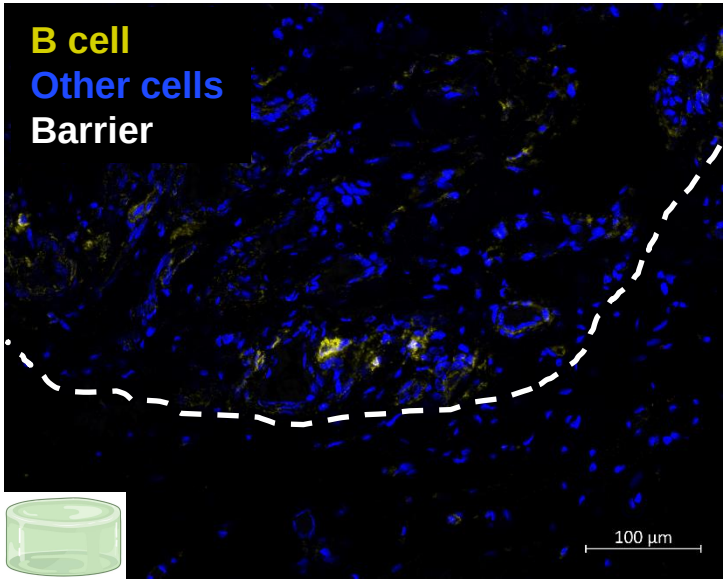
Pro-fibrotic materials



Immature B cells

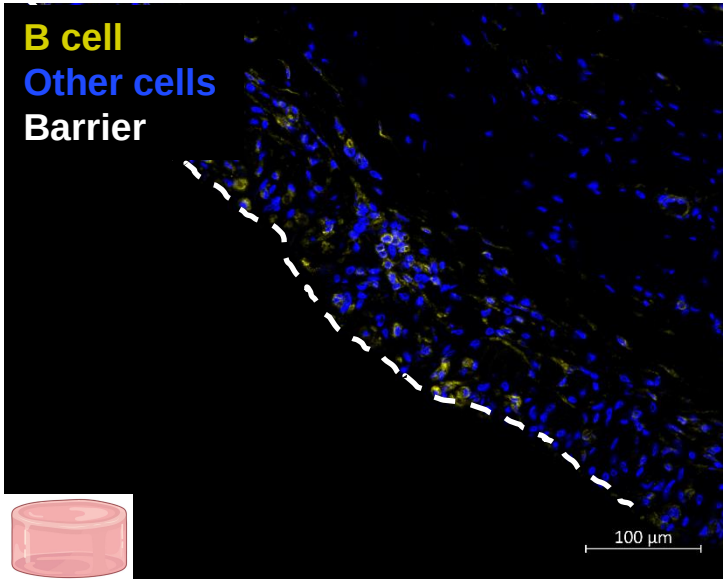
Mature B cells

Biomaterials implanted in breast tissue



- Patients with naturally-derived materials

Pro-healing materials

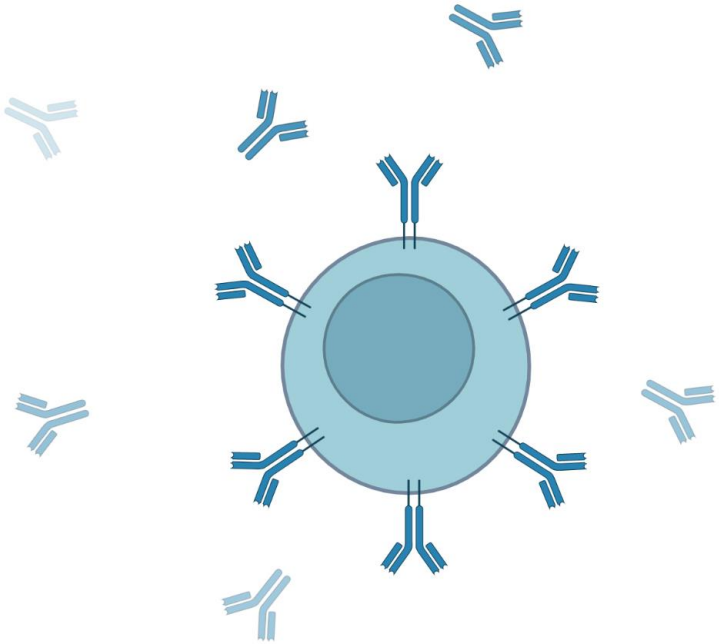


- Patients with silicone implants

Pro-fibrotic materials

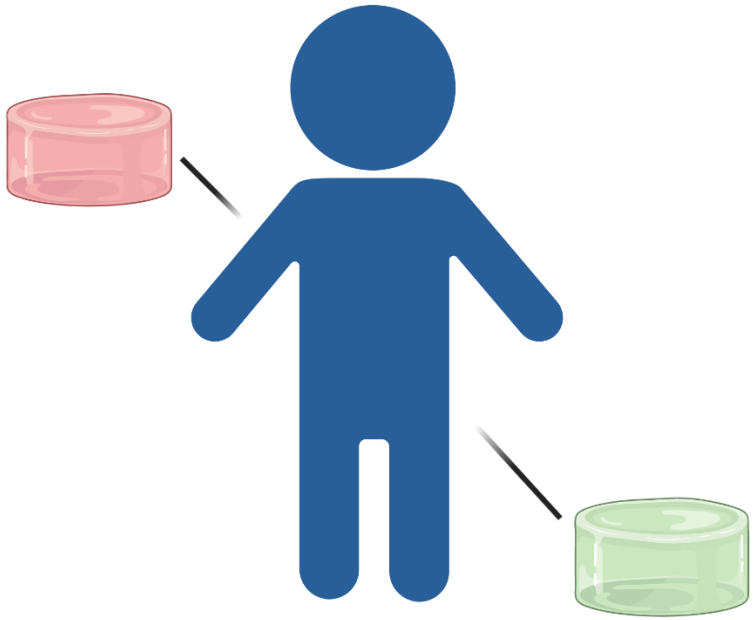
Gaps in understanding

- Adaptability of the B cell response in wound healing?
- Local tissue response can inform the systemic response



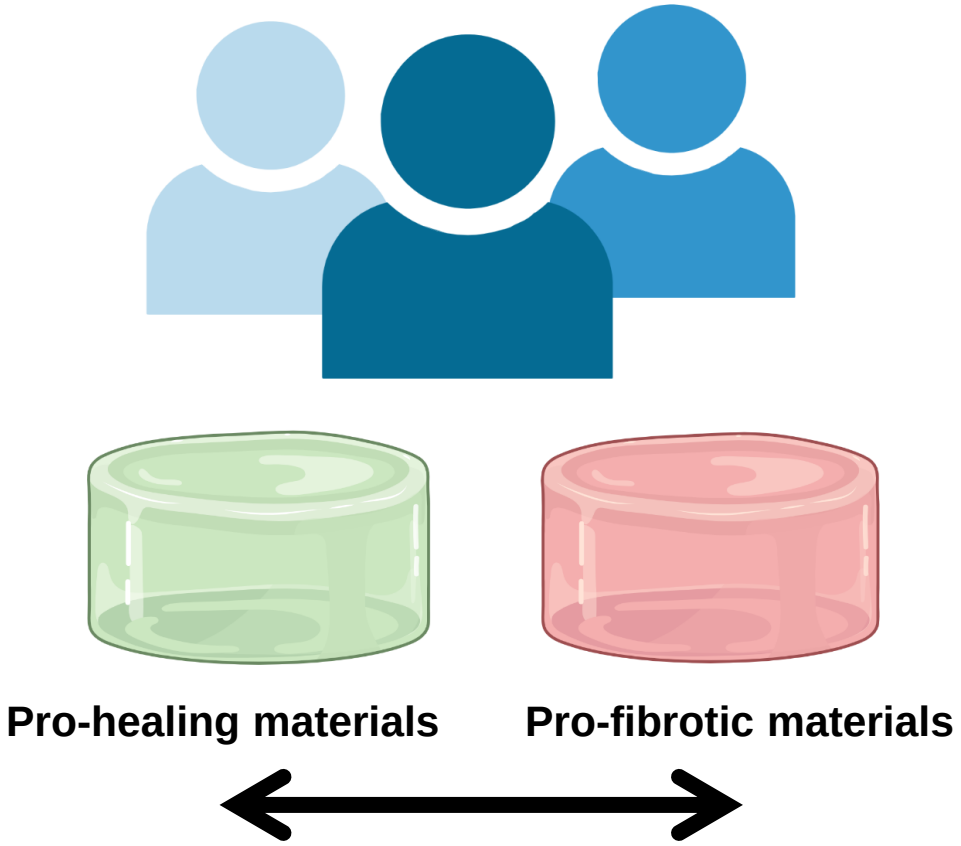
Gaps in understanding

- How do we connect the local injury response to systemic immunity?
- How do we leverage biomaterial models to understand patient-specific wound healing?



Biomaterials can be used to stratify the immune response in wound healing

- Can certain biomaterials mimic wound healing conditions of vulnerable populations?

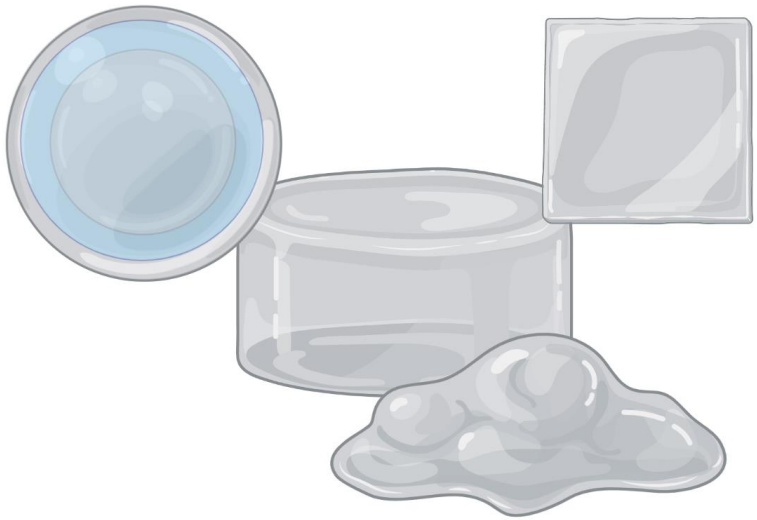


Open research questions

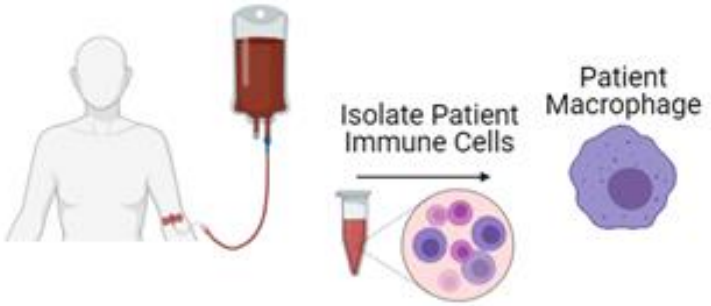
- Can we interrogate the contribution of patient variability in wound healing?
  - Ancestral contributions
  - Age
  - Biological Sex
  - History of Trauma

How can we use biomaterials to improve tissue regeneration?

- Biomaterial systems offer controlled systems for interrogation
- Use of organoid biomaterials to achieve patient specificity



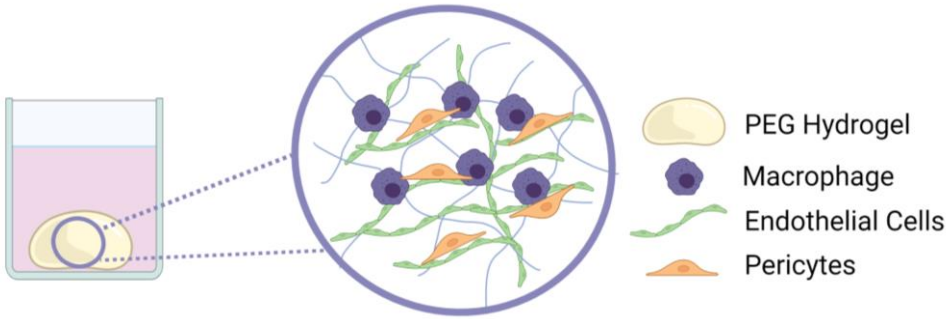
Biomaterials to interrogate age in regeneration



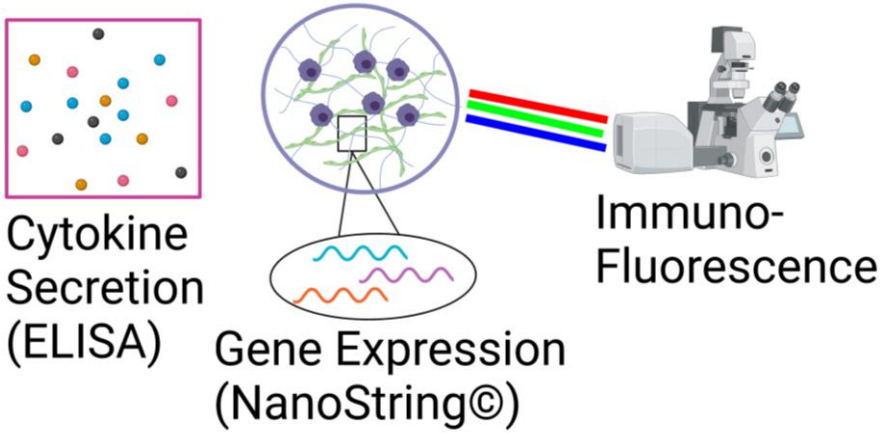
Immune Cells are influenced by:

- Ancestral contributions
- **Age**
- Biological Sex
- History of Trauma

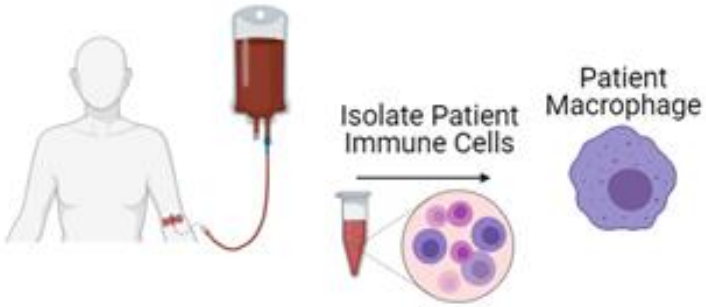
Biomaterial Model of Aging



Analysis in Biomaterials

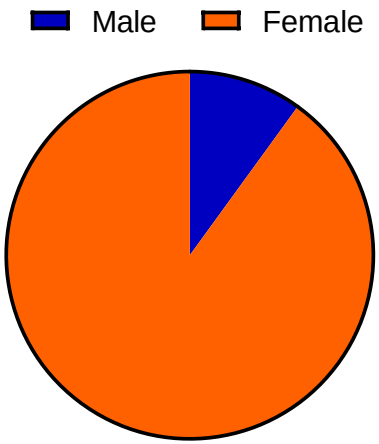


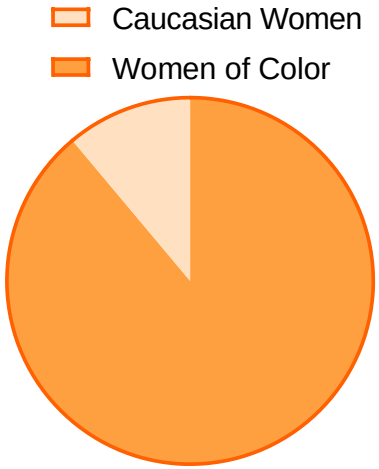
Biomaterials to interrogate health inequities



Immune Cells are influenced by:

- **Ancestral contributions**
- Age
- **Biological Sex**
- History of Trauma





- Systemic Lupus Erythematosus (SLE)
  - People with lupus develop inflamed blood vessels
- Biomaterial model of lupus

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Thank you!

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David Maestas
Justin Silberman
Holly Ryan

All schematics created in BioRender

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