Extracellular Matrix

- Proteins and sugars that surround cells
- Collagen is most abundant
- Provides strength
- Supports cell survival
- Different between tissues
Traditional Synthetic Biomaterials

- Metals
- Polymers
- Ceramics
Ex. Titanium

• Strong

• Some flexibility = Ductile

• Good conductors or heat and electricity

• Can corrode
Ex. Alumina

- $\text{Al}_2\text{O}_3$
- Excellent Wear Resistance
- Bearing Surfaces
- Orthopedic & Dental Applications
- Can be brittle
Ex. Polyethylene

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\end{align*}
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- Light
- Flexible
- Good insulators of heat and current
- Moderate wear resistance
What Do These Biomaterials Share in Common?

The answer is: that they were not originally engineered for biomaterials applications!

Humans are not built from traditional engineered materials.
1. Injury with tissue and vascular damage

2. Bleeding and clotting – Coagulation Cascade (Minutes to Hours)

3. Acute Inflammation – Neutrophils, Macrophages, and fibroblasts (Hours to days)

4. Pink highly vascularized granulation tissue replaces the provisional matrix (days to weeks) – fibroblast cells

5. The tissue is remodeled back to its original state

The phases of cutaneous wound healing

Expert Reviews in Molecular Medicine © 2003 Cambridge University Press
Synthetic Materials Alter the Healing Response

1. Injury with tissue and vascular damage

2. Bleeding and clotting – Coagulation Cascade (Minutes to Hours)

3. Acute Inflammation – Neutrophils and Macrophages (Hours to days)
1. Injury with tissue and vascular damage

2. Bleeding and clotting – Coagulation Cascade (Minutes to Hours)

3. Acute Inflammation – Neutrophils and Macrophages (Hours to days)

4. Chronic Inflammation – Macrophages can't remove the synthetic biomaterial so they persist at the wound site

Synthetic Materials Alter the Healing Response
1. Injury with tissue and vascular damage

2. Bleeding and clotting – Coagulation Cascade (Minutes to Hours)

3. Acute Inflammation – Neutrophils and Macrophages (Hours to days)

4. Chronic Inflammation – Macrophages persist at the implant site

5. Fibroblasts deposit a fibrous encapsulation layer

Synthetic Materials Alter the Healing Response
What Do These Biomaterials Share in Common?

The answer is: that they were not originally engineered for biomaterials applications!

Synthetic materials are incapable of regenerating damaged tissue.

There is a need for advanced ECM biomaterials which mimic the structure, composition, and function of biological tissues.
Clinical Target: Volumetric Muscle Loss

Case Report

- IED injured 22 Year old soldier
- Upper extremity injury with significant loss of muscle

Objective

- Provide surgeons with a treatment option for VML injuries
**Skeletal Muscle**

- Highly organized
- Multinucleated fibers
- Fibers and bundles are surrounded by ECM

**Guiding Principle**

ECM provides critical regenerative cues during VML healing.
ECM Biomaterials

Engineering Objective

- Build ECM materials that restore the regenerative cues provided by the native muscle ECM

Top Down

- Strip the cell from whole muscle
- Collect the remaining ECM

Bottom Up

- Culture muscle cells
- Collect the ECM that they secrete (engineered ECM)